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# CONTENTS

## KEYNOTE ADDRESSES

<i>Power-Electronics Issues of Modern Electric Railway Systems</i> A. STEIMEL .....	1
<i>New Advances and Possibilities in Active Circuit Design</i> H. Hakan KUNTMAN .....	9

## INVITED ADDRESSES

<i>Magnetization Dynamics for Nonvolatile Memory Technologies</i> Leonard SPINU .....	19
<i>Improved Pulses Generated By Piece-wise Parabolic Nyquist Filters</i> Nicolae Dumitru ALEXANDRU .....	20

## SECTION A

<i>Option to Provide the Necessary Feedback for Closed-Loop neuroStimulation</i> Radu BAZAVAN, Rodica STRUNGARU .....	21
<i>Obstacle Avoidance Fuzzy System for Mobile Robot with IR Sensors</i> C. G. RUSU, I. T. BIROU .....	22
<i>Hazardous Events Monitoring System in a Hospital</i> Radu ȚIGĂNESCU-AMARIȚII .....	23
<i>Real-time Communications for Distributed Control Systems</i> Dan PUIU, Florin MOLDOVEANU, Caius SULIMAN .....	24
<i>Design and Comparison of Different Switched Reluctance Machines Topologies for Automotive Applications</i> Claudia MARTIS, Vlad PETRUS, Adrian-Cornel POP, Johan GYSELINCK .....	25
<i>The VSB-01 Portable System for Monitoring Environmental Conditions</i> Alexandru SUCIU, Vasile BUZDUGA, Gabriela VIZITIU .....	26
<i>Computer Program for Studying the Operation of Gas Turbine Plants</i> Pavel ATĂNĂSOAE, Gicu OICĂ .....	27

<i>Kalman Filter Based Tracking in an Video Surveillance System</i> Caius SULIMAN, Cristina CRUCERU, Florin MOLDOVEANU .....	28
<i>A Fuzzy Approach Regarding the Optimization of Statistical Process Control through Shewhart Control Charts</i> Alexandru-Mihnea SPIRIDONICĂ, Marius PISLARU, Romeo-Cristian CIOBANU .....	29
<i>Multiagent System for Robotic Vision System</i> Dan FLOROIAN, Florin MOLDOVEANU, Mihai CERNAT.....	30
<i>The use of Fuzzy Modelling Regarding the Assurance of Environmental Protection</i> Alexandru-Mihnea SPIRIDONICA, Marius PISLARU.....	31
<i>Experience-Based Design and Simulations of a Fuzzy Control System for Cardiovascular Variables</i> Cristian BOLDIȘOR, Vasile COMNAC, Iulian ȚOPA .....	32
<i>A Methodology of Power Demand Prediction</i> Corina MARTINEAC, Oana ONET, Simona ARDELEAN, Claudiu VERMEȘAN, Mihai HOPÎRTEAN, Tudor VESA .....	33
<i>μC/OS-II Real Time Kernel Port for Cirrus Logic EP93xx Platform</i> Eugen DODIU, Adrian GRAUR, Cristina N. GAITAN, Vasile G. GAITAN, Adrian M. GAITAN.....	34
<i>Analytic Method for Determination of the Amplitude-Phase Transmission Errors Between Selsyns</i> Gabriel GHIDUS, Alecsandru SIMION, Leonard LIVADARU, Sorin MIHAI.....	35
<i>Thunderstorms as Interactive Component of Global Ecodynamics</i> V.F. KRAPIVIN, C. NITU, V.Yu. SOLDATOV .....	36
<i>Analysis and Simulation of Unbalanced Systems</i> Virgil MAIER, Antoniu TURCU, Sorin PAVEL, Iulian BIROU .....	37
<i>Hybrid Electric Vehicle Experimental Model with CAN Network Real Time Control</i> Gheorghe LIVINȚ, Vasile HORGA, Daniel STICEA, Marcel RĂȚOI, Mihai ALBU.....	38
<i>The Iterative Algorithm of Tuning Controllers to the Model Object with Advance and Inertia Second Order</i> Bartolomeu IZVOREANU .....	39
<i>Tuning Controllers in the Multiple-Loop Feedback Control System to the Objects with Inertia, Time Delay and Non Minimal Phase</i> Irina COJUHARI.....	40
<i>Fuzzy Model for Sustainability Assurance Related to Environmental Protection</i> Marius PISLARU, Alexandru TRANDABAT, Cristina SCHREINER, Alexandru SPIRIDONICA.....	41
<i>Mechanical-electrical Optoisolator Transducer with current-to-frequency Conversion</i> Ioan Marcel CIURUȘ, Mihai DIMIAN, Adrian GRAUR.....	42

<i>A Short Survey on Applications of Rough Sets Theory in Power Engineering</i> Ioana PISICĂ, Petru POSTOLACHE .....	43
<i>Middleware Based Model of Heterogeneous Systems for SCADA Distributed Applications</i> Nicoleta-Cristina GĂITAN, Vasile Gheorghiuță GĂITAN, Ștefan Gheorghe PENTIUC, Ioan UNGUREAN, Eugen DODIU .....	44
<b>SECTION B</b>	
<i>Time of Arrival Based on Chirp Pulses as a means to Perform Localization in IEEE 802.15.4a</i> <i>Wireless Sensor Networks</i> Anneleen VAN NIEUWENHUYSE, Jeroen WYFFELS, Jean-Pierre GOEMAERE, Lieven DE STRYCKER, Bart NAUWELAERS .....	45
<i>A New Family of CSK Signals</i> Nicolae Dumitru ALEXANDRU .....	46
<i>Some Useful Properties of STBC codes for Residential Applications</i> Angela DARIE, Mihai GHENGHEA, Ion BOGDAN .....	47
<i>Spectral Analysis of Three Miller-like Codes</i> Nicolae Dumitru ALEXANDRU .....	48
<i>A New Evolutionary Approach for Base Station Transmitter Placement</i> Shahriar MAHBUB, Nusrat SHARMIN .....	49
<i>An Optimization of Gaussian UWB Pulses</i> Adrian POPA .....	50
<i>The Impacts of Temperature on PMD and CD Dispersions During High Speed Optical</i> <i>Communications</i> Nikola STOJANOVIĆ, Miodrag JELIĆ, Miloš SLANKAMENAC, Miloš ŽIVANOV .....	51
<i>New High Performance Deterministic Interleavers for Turbo Codes</i> Georgian Alexandru LAZAR, Nicoleta Roxana BUZATU, Elena COJOCARIU, Lucian TRIFINA, Razvan VIERU .....	52
<i>A Comparative Approach on WiMax and LTE Technologies</i> Mihai-Florentin URSULEANU, Daniel SIMION, Adrian GRAUR, Alin Dan POTORAC .....	53
<i>Data Communications in an HPC Hybrid Cluster and Performance Evaluation</i> Ovidiu GHERMAN, Ioan UNGUREAN, Ștefan Gheorghe PENTIUC, Oana VULTUR .....	54
<i>LTE eNodeB Demonstrator with Real and Simulated Interfaces</i> Titus-Constantin BĂLAN, Florin SANDU, Szilard CSEREY, Virgil CAZACU .....	55
<i>Simulation of LTE Signaling</i> Florin SANDU, Szilárd CSEREY, Eugen MILE-CIOBANU .....	56

<i>BPEL Implementation of QoS-based Management in Multi-modal Mobile Communications,</i> Florin SANDU, Dan Nicolae ROBU, Cosmin COSTACHE .....	57
<i>Eigenvalue Characterization of the Sum Capacity of Multi-User MIMO Multiple Access Channels</i> Paul COTAE.....	58
<b>SECTION C</b>	
<i>Assigning Connection Sources in Large-Scale Circuits Multilevel Decomposition</i> Olivian STĂNICĂ.....	59
<i>The Modeling of the Heating Resistors in Transient Regime</i> Mitica Iustinian NEACA, Andreea Maria NEACA .....	60
<i>Electronic Devices for Determining the Working Length in Root Canal Therapy</i> Anca POPESCU .....	61
<i>A Study in Binary Relations for Logic Algebra Functions</i> Ion COJOCARU, Andrei VASILĂȚEANU, Octavian IONEL.....	62
<i>Study of Binary Relations of Boolean Algebra Functions</i> Ion COJOCARU, Octavian IONEL.....	63
<i>Electrical and Switching Parameters of Amorphous Chalcogenide Glassy Semiconductors</i> $Cu_5(AsSe_{1.4}I_{0.2})_{95}$ Miloš SLANKAMENAC, Svetlana R. LUKIĆ, Miloš ŽIVANOV.....	64
<i>Analysis of Coupled Oscillators through a Series RLC Network</i> Iulia DUMITRESCU, Mihai IORDACHE, Mihaela IONITA .....	65
<i>Sensitivity and Tolerance Analysis in Analog Circuits Using Symbolic Methods</i> Lucian MANDACHE, Mihai IORDACHE, Lucia DUMITRIU .....	66
<i>HDL Implementation from Petri Nets Description</i> Viorica SUDACEVSCHI, Victor ABABII, Emilian GUTULEAC, Valentin NEGURA .....	67
<i>Induction Motor Control with Predicted Maximum Electromagnetic Torque and Speed</i> Nicoleta Roxana BUZATU, Dimitrie ALEXA, Georgian Alexandru LAZAR, Dan BUTNICU, Oana Loredana BUZATU .....	68
<i>Temperature Influence on Conversion Efficiency in the Case of Photovoltaic Cells</i> Corina MARTINEAC, Mihai HOPÎRTEAN, Gilbert DE MEY, Vasile ȚOPA, Silviu ȘTEFĂNESCU.....	69
<i>GPRS Controlled System for Monitoring and Control of Well Sites</i> Vladimir MILOSAVLJEVIC, Milos ZIVANOV, Viktor DOGAN .....	70



<i>Cordless Seismic Data Acquisition System</i> Miodrag BRKIC, Predrag TEODOROVIC, Milan LUKIC, Milos ZIVANOV .....	71
<i>Borehole Orientation Sensor - Hardware Realization</i> Viktor DOGAN, Milos ZIVANOV, Miodrag BRKIC .....	72
<i>Indoor Inter-Robot Distance Measurement in Collaborative Systems</i> Mihai V. MICEA, Andrei STANCOVICI, Dan CHICIUDEAN, Constantin FILOTE.....	73
<i>On Resonance Charts of Piezoelectric Ceramics of Perovskite-Type, in Microwave Range</i> Daniela IONESCU, Iulia Brîndușa CIOBANU .....	74
<i>Finite State Machine Design and VHDL Coding Techniques</i> Iuliana CHIUCHISAN, Alin Dan POTORAC, Adrian GRAUR .....	75
<i>Synchronous Overmodulation Control of Cascaded Inverters for Photovoltaic Application</i> Valentin OLESCHUK, Roman PRUDEAK, Alexandr SIZOV .....	76
<i>Hysteresis Modelling of Soft Magnetic Materials using LabVIEW Programs</i> Septimiu MOTOASCA, Gheorghe SCUTARU .....	77
<i>Performance Evaluations and Comparative Electromagnetic Compatibility Measurements on Compact Fluorescent Lamps</i> Georgiana BUTA, Eugen COCA, Adrian GRAUR, Valentin POPA.....	78
<i>Analysis of Beamforming in Phased Antenna Arrays</i> Octavian MANU, Mihai DIMIAN, Adrian GRAUR .....	79
<i>Audio Source Localization, using a Network of Embedded Devices</i> Laurențiu FRANGU, Marius MĂZĂREL, Claudiu CHICULIȚĂ.....	80
<i>Modeling of Ferrite Common Mode Chokes for EMI Suppression in LTCC Technology</i> Mirjana DAMNJANOVIĆ, Ljiljana ŽIVANOV, Miloš ŽIVANOV.....	81
<i>Embedded System for Start of ICE with Hybrid Battery-Super-capacitor Sources</i> Aurel Cornel STANCA, Venetia SANDU, Iuliu SZEKELY .....	82
<i>Magnetic Properties of Two-Dimensional (2D) Heisenberg Lattices as Good Candidates for Spintronic Junctions</i> Jacques CURÉLY .....	83
<b>SECTION D</b>	
<i>A New Hybrid Genetic Algorithm for The District Heating Network Problem</i> Mitică CRAUS, Florin LEON, Dragos AROTĂRIȚEI.....	84
<i>Information Security Policy in the Distributed Computer Systems</i> Vadym MUKHIN, Artem VOLOKYTA.....	85

<i>Analysis and Determination of Risk Factors Leading to Preterm Birth Using Data Mining Techniques in R</i> Adriana-Georgiana MALEA, Ștefan HOLBAN, Nicolae MELIȚĂ .....	86
<i>Embarking on the road of Intrusion Detection, with Erlang</i> Ioan Alfred LETIA, Dan Alexandru MARIAN.....	87
<i>Argumentative Support for Structured HACCP Plans</i> Ioan Alfred LETIA, Adrian GROZA .....	88
<i>Applied Realization of Neural Network and Neurolike Parallel-Hierarchical System Based on GPGPU</i> Andriy YAROVYY .....	89
<i>An Ontological Approach to Legal Literature for Improving Legal Knowledge Dissemination</i> Ioan Alfred LETIA, Sorina CORNOIU.....	90
<i>Architectural Views for Designing Relationships in Distributed Systems</i> Anca Daniela IONITA, Jacky ESTUBLIER .....	91
<i>Value Based Argumentation using Formal Concepts</i> Ioan Alfred LETIA, Anca GORON.....	92
<i>Ontology Based Modeling of Cultural Heritage Systems</i> Dorin-Mircea POPOVICI, Crenguta-Madalina BOGDAN, Ronan QUERREC .....	93
<i>Some Aspects of Data Integration in Data Mining Systems</i> Mirela DANUBIANU, Emanuela-Alina BOLOHAN, Radu ȚIGĂNESCU-AMARIȚII.....	94
<i>Formation of Microrelief on the Base of Multilevel Elevations Maps</i> Sergei I. VYATKIN, Oksana V. ROMANIUK.....	95
<i>The BRDF Models Based on the Cosine-quadratic Function</i> Alexander ROMAHIYUK, Yuri LYASHENKO.....	96
<i>VRDN: A Software Environment for Visual Simulation of Rewriting Generalized Timed Differential Petri Nets Models</i> Emilian GUȚULEAC, Iurie ȚURCANU, Ion BALMUȘ, Victor CHEIBAȘ, Alexei CORDUNENU .....	97
<i>Technology Approach to Individual "Knapsack Problem" (Nanologistics)</i> Sergey RYVKIN, Denis KRASNOVSKI.....	98
<i>Cryptoresistant Generator of Binary Key Sequences on the Basis of Cellular Automata</i> Sergey OSTAPOV, Vladimir ZHIKHAREVICH, Lidiya VAL' .....	99
<i>ICT serves Business Training: Implementing Life-Long-Learning</i> Timothy HALL, Ileana HAMBURG, Emma O'BRIEN, Sinead MELLETT .....	100
<i>New trend on OPC Middleware</i> Simona-Anda GHERASIM, Adrian Mihai GĂITAN, Vasile Gheorghîță GĂITAN, Valentin POPA .....	101

<i>A Bee-inspired Approach for Selecting the Optimal Service Composition Solution</i> Cristina Bianca POP, Viorica Rozina CHIFU, Ioan SSLOMIE, Mihaela DINSOREANU, Mihaly FODOR .....	102
<i>Modelling the Probability of Deadlocks in a Multithreading Process</i> Doina LOGOFĂTU, Felix DIETRICH, Evgeni PAVLIDIS, Dennis WILFERT .....	103
<i>System for Real Time Detection of Hands and Pedestrians Movements</i> Gina CRĂCIUN, Ionela RUSU, Ștefan-Gheorghe PENTIUC, Radu Daniel VATAVU .....	104
<i>The Application of Genetic Algorithm for Training "Without a Teacher"</i> Valeriy FRATAVCHAN .....	105
<i>HL7 Messaging Engine with Customizable Translation System</i> Marius CERLINĂ, Cristina TURCU, Tudor CERLINĂ, Remus PRODAN .....	106
<i>A Distributed RFID Based System for Patients' Identification and Monitoring</i> Tudor CERLINĂ, Remus PRODAN, Cornel TURCU, Marius CERLINĂ .....	107
<i>Index of Authors</i> .....	108

## **25 YEARS OF ELECTRICAL ENGINEERING HIGHER EDUCATION IN SUCEAVA**

<i>Timeline History</i> .....	114
<i>Academic Staff</i> .....	117
<i>Inventions Center</i> .....	119
<i>EMAD - Research Center in Electrical Machines, Apparatus and Drives</i> .....	123
<i>SiSCON - Systems and Processes Control Research Center</i> .....	124
<i>CCSC - Computer Science Research Center</i> .....	125



# Power-Electronics Issues of Modern Electric Railway Systems

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**Abstract** — After de-regulation of the former state-owned railways and severe restructuring of the railway industry in the last 15 years, more innovative vehicle concepts saw the light of the day. Power electronics, already formerly being a pacemaker for progress of traction vehicles, brought forth an utmost standardization of the main drive by means of the IGBT-converter-fed induction motor drive. This is independent of the railway supply voltage system or of a diesel prime mover, for locomotives, high-speed and mass-transit trains as well as for tramways. Vehicles able to operate on all four European railway voltage systems have become feasible and are used now widely. New trends as Permanent-Magnet Synchronous Motors or Medium-Frequency Transformers are discussed, and a short overlook over actual field-oriented high-performance motor control systems – including a speed-sensorless variant – is given. Power electronics dominates the field of conversion of the 16.7-Hz railway supply power, typical for Central Europe, from the 50-Hz three-phase utility grid.

**Index Terms** — railway systems, induction motor drive, IGBT-converter-fed

## I. INTRODUCTION

During the second half of the 20th century, the railways' importance declined due to the rise of individual transport, in the form of the private motor car and the truck, as well as the air- plane, whose speed and versatility the railway could not apparently match. Only by the close of the century, a change of mind set in: Due to congestion of public traffic by individual transport, track-bound public mass transit becomes more and more appealing. But governmental control proved inadequate to meet the demands to the railway systems; thus, programs of decentralization and deregulation were applied to railway transit. EU Directive 91/440 intended to enable and organize the barrier-free coexistence and competition of governmental and private railway operators, splitting the formerly state-owned railways into industrially-organized, competing train operators and further-on state-owned infrastructure providers.

Ever since the beginning of the 1990s, the European railway industry had to face constant change; the restructuring of the railway organisations by deregulation and privatization led first to a decline in orders and in consequence to amalgamation. Engineering industry divisions formerly responsible for the supply of the mechanical components of traction units were integrated into the transportation divisions of the electrical large-scale industrial companies, the latter now acting as leaders of system technology. This holds most directly for ALSTOM, Siemens and the former ABB/ADtranz; Bombardier Transportation – which absorbed ADtranz and most of the

remaining European carbuilders – is part of the Canadian global transportation company Bombardier, while the Swiss "newcomer" Stadler Rail is a carbuilder, who founds on inverters from ABB Industry. More innovative and – by standardization – at the same time economically competitive vehicle concepts were to be developed.

## II. INNOVATIVE TRACTION MATERIAL

### A. Locomotives

Since WWII, the four-axle bogie locomotive has been standard in passenger and goods service. The converter-fed induction motor drive allowed "universal" locomotives with high tractive effort at low speed, a rated power of up to 6.4 MW, running stably at maximal speeds up to 357 km/h ([1]; Fig. 1).

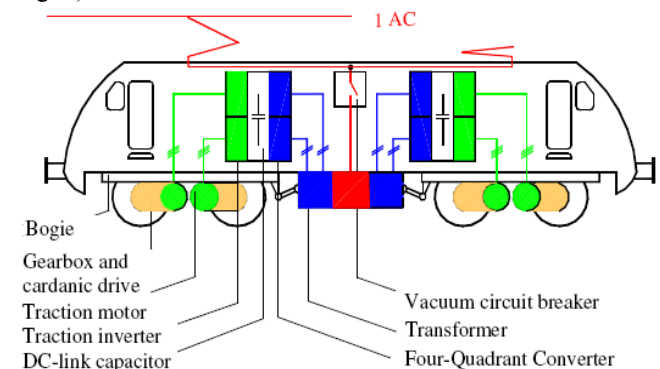


Figure 1. Modern high-power AC-fed bogie locomotive.

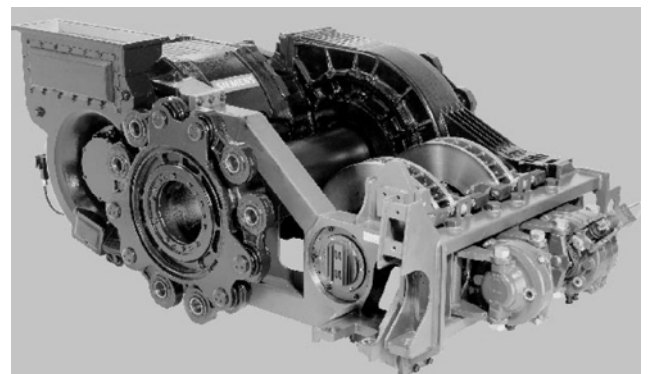


Figure 2. 1.6-MW cardan hollow-shaft drive with rubber joints, brake discs on extra high-gear shaft in front (ÖBB 1216, Siemens).

The bogies are mostly supported by Flexicoil springs; the cardan hollow-shaft drive with rubber joints is standard ([2]; Fig. 2), except for lower-power vehicles, where simpler forms as the "axle-riding" drive with the motor mounted in the bogie and an elastic coupling between motor and gear to the axle or axle-hung motors for low-speed vehicles are sufficient [1].

The line-friendly Four-Quadrant Converter (4q-C, [3]) is standard with all AC-fed traction vehicles.

**B. High-Speed Trains**

The first generation of high-speed trains (HST) as TGV in France and ICE in Germany pursued the Power Head concept (Fig. 3, top), with special asymmetric, streamlined locomotives and trailers. Due to the heavy axle-load of 18...20 to, this is not suited for speeds over 250 km/h. The distributed drive with about half or three-quarter of the axles driven with lighter motors prevails now, as in Japanese design, while the electronic equipment and the transformers are mounted underfloor (Velaro [4], AGV [5],  $v_{max} = 350$  kph; Fig. 3 bottom). Tilting [6] raises commercial speed up to 220 kph on curved secondary main-lines, where high-speed upgrading is not justified.

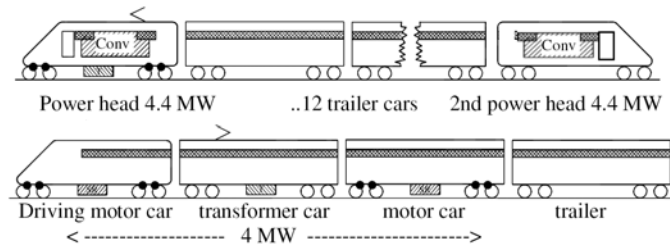


Figure 3. High-speed trains with power heads and as EMUs.

**C. Mass Transit Trains**

The classical EMU Metro Train is supplemented by modern design as bogieless lightweight articulated trains with self-steering axles or more conventional articulated trains with small-wheel bogies and depressed floors, to ease access from standard 750-mm platforms (Fig. 4); the power-electronic equipment (and transformer, if AC) is mounted underfloor. Modern trains allow to ambulate freely through all coaches, raising the passengers' feeling of safety and thus the acceptance in the late night hours. Self-propelled double-deck commuter EMUs which use the restricted platform lengths of existing suburban and regional railway systems best are ordered increasingly.

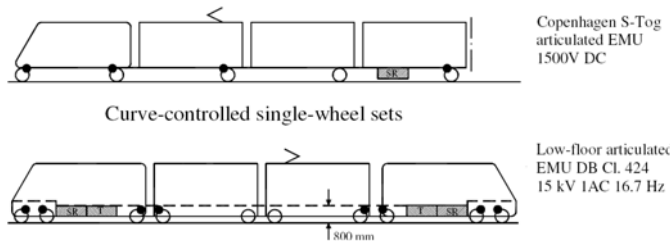


Figure 4. Modern Mass-Transit Trains.

**D. Low-Floor Light Rail Vehicles (Tramways)**

To compete better with individual transport, municipal operators and industry strived for raising comfort of tramways by introducing low-floor trains in the nineties of the last century [7]: In the so-called "70% trams" more or less conventional traction bogies with smaller wheels are used (Fig. 5, top). Single-wheel drives are necessary in the "100% trams", to allow free passage over the floor, which is only 200...300 mm over ground, accessible directly with one step (Fig. 5 bottom). The power electronic (and air-conditioning) equipment has to be mounted on the roofs of the trains.

Dual-system Light Rapid Transit vehicles (Tram Trains) in several German and French cities use the railways' AC

lines in an environment of some 150 km and revert to DC street-level operation when approaching the very centres of these cities.

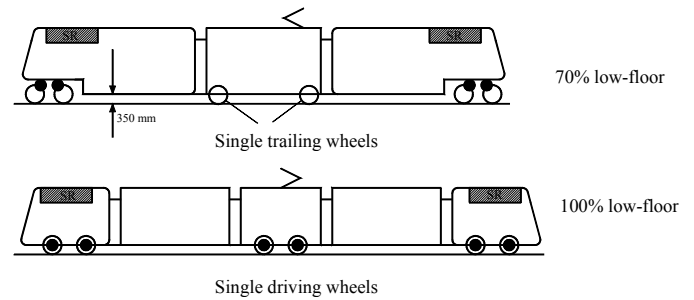


Figure 5. "70%" and "100%" low-floor tramways.

This makes public transport more attractive, especially if the main station is far from the city centre. The main constructional difference between light rail and railway vehicles – besides a smaller vehicle gauge and a compromise wheel-tire profile – is the lesser resistance to longitudinal impacts.

**III. RAILWAY POWER SUPPLY VOLTAGE SYSTEMS**

Originating from the beginning of the 20<sup>th</sup> century, four major railway power supply system exist: DC 1.5 kV and 3 kV, AC 50 Hz, 25 kV and AC 16.7 Hz, 15 kV [8], Fig. 7. The DC 1.5 kV system developed from suburban lines of the big capitals. DC 3 kV was introduced in the twenties, to increase the range.

The AC systems were introduced for long-distance traffic from the beginning. Initially, the special low frequency of 16.7 Hz was necessary to enable sparkles commutation of the series-wound motor excited with AC. 50 Hz could only be established after introduction of (first) the mercury-arc and (later) the thyristor-controlled rectifier, together with "undulating-current" DC motors.

The power systems show now rather stable, we only face a superposition of DC systems by 50-Hz systems in case of high-speed, high-power lines, which the old DC systems cannot sustain (France, Spain, Netherlands, Italy).

Table 1 gives an overview of the lengths and the relative proportion of the four main-line power systems. Tramways and underground preferably use DC 600...800 V.

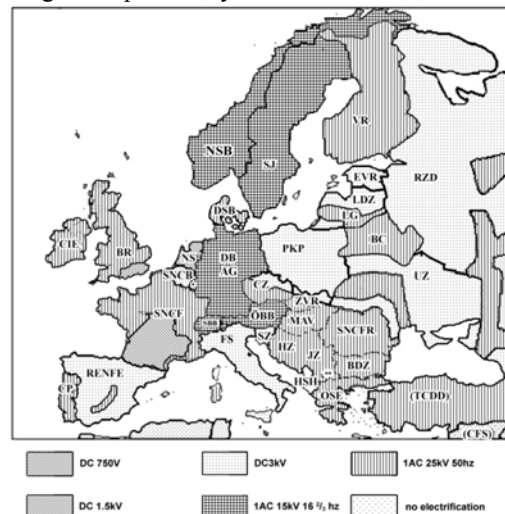


Figure 6. Railway main-line power-supply systems in Europe.

TABLE I. NETWORK LINE LENGTHS AND PROPORTION OF ELECTRICAL RAILWAY SYSTEMS (2003)

System	Length (km)	Proportion (%)
DC 1500 V	15,320	6.5 %
DC 3000 V	72,105	30.3 %
AC 15 kV/16 2/3 Hz	32,390	13.6 %
AC 25kV/50 (and 60) Hz	106,437	44.8 %
Others	11,350	4.8 %
Total	237,600	100.0 %

IV. MAIN DRIVE CONCEPTS

In former times, the power system and the main-drive concept were rather rigidly tied together [1]: AC 16.7 Hz 15 kV appeared mainly with transformer, switch-gear and series-wound, compensated commutator motors; in the seventies, thyristor-control was introduced, mainly in Austria. 50 Hz necessitated thyristor phase-control, as already mentioned, and DC motors, mainly with separate or mixed excitation. In DC grids, the original camshaft-resistor control of series-wound commutator motors was replaced by thyristor chopper control in the sixties. Multi-system vehicles capable to run on more than two systems were extremely expensive and thus seldom.

The French system of synchronous motors, fed by load-commutated thyristor converters, as in the TGV-A [9], have shown an intermediate step to the now generally preferred drive system with squirrel-cage induction motors, fed by Voltage-Source Inverters (VSI, [10]). Fig. 6 shows the identical drive structure of DC-fed trams, diesel-electric locomotives and full-electric locomotives with the VSI-IM drive system.

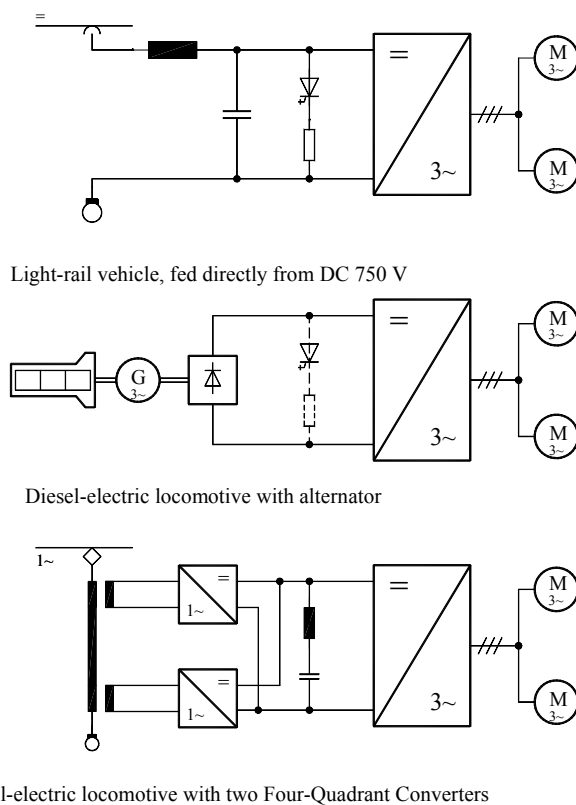


Figure 6. Schematic diagram of traction vehicles with three-phase IM drive technology.



Figure 7. DB Class 120 and Austrian (ÖBB) Class 1216.

The converters were first (from 1971 on) equipped with force-commutated thyristors, as in Class 120 of Deutsche Bahn (DB, Fig. 7, left), later by Gate-Turn-Off (GTO) thyristors [11]. Around the year 2000, the GTO was detached by the IGBT transistor, with blocking voltages of up to 6.5 kV and turn-off currents of 600 A [12], which can be turned off safely even in short-circuit condition. As they are able to operate directly from the 3 kV overhead lines (with transients up to 5 kV), they allow a very simple and robust multi-system concept, as in ÖBB (Austria) Cl. 1216 "Taurus", Fig. 6, right; Siemens ([2]).

An alternative concept uses the line-side Four-Quadrant Converter as step-up chopper in the 1.5 kV DC grid and as step-down chopper in the 3-kV grid (Swiss Cl. 484, circuit Fig. 8, [14]). This allows use of 4.5-kV IGBT with better switching characteristics and less voltage stress of the motor insulation, as the DC-link is always kept constant at 2.8 kV (Bombardier).

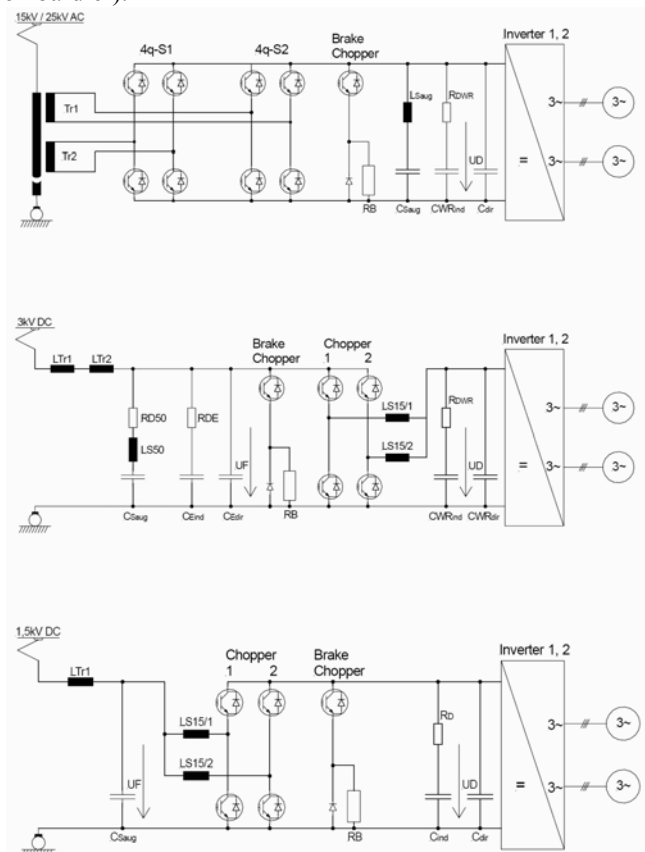


Figure 8. Circuit diagram of SBB Class 484 four-system locomotive.

Diesel-electric locomotive (which by far stand for the biggest part of locomotives all over the world) with AC generator and diode bridge rectifier can now be built to the same "platform" design as full-electric locomotives, with same starting effort, but about half the rated power, due to the weight of the engine. Bombardier unified the



construction thus that in the same carbody with identical bogies and motors the electric "E-PowerPackage" can be replaced by a "D-PowerPackage" [14].

Fig. 9 shows a recent air-cooled 200-kW IGBT inverter for 600...750 V from the German manufacturer Vossloh-Kiepe, for tramways and trolley busses, Fig. 10 a converter TC 3200 from Bombardier, for one bogie of a high-power locomotive or a HST power-head.



Figure 9. Inverter Vossloh Kiepe DPU 409 for light-rail application.



Figure 10. Inverter Bombardier TC 3200 for high-power locomotives.

## V. NEW TRENDS IN DRIVE CONCEPTS

### A. On-Board Energy Storage

Energy storages are of interest for intermediate storage of the brake energy, for reduction of the peak power demand and infrastructure losses, to enable short sections without catenary in historic cities, in shops or at track works and for relieving a diesel motor at acceleration, rated for the average power only.

Flywheel storages have been tested in hybrid busses and trams, e.g. in Rotterdam. They are built of very strong carbon-fibre materials and driven by inverter-fed permanent-magnet synchronous machines (PMSM); the maximum attained speed is at 12,000 rpm, the usable energy 1.5...2 kWh.

Supercap storages, coupled with two-quadrant converters to the DC link, have been tested for several years at the municipal tramways of Mannheim [15]; now an order of 18 trains for Heidelberg is under delivery (Bombardier MITRAC Energy Saver).

Nice City Light Rail is bridging wireless sections, not equipped with overhead contact line, of less than 450 m by means of a NiMH high-performance battery, since July 2007.

### B. Permanent-Magnet Synchronous Motors

Recently new technologies for synchronous motors, like the permanently-excited type with rare-earth magnets (PMSM, [16]), fed from individual IGBT inverters, are under test. As they offer a considerably higher power-to-weight ratio than induction motors, they are most promising for HSTs and low-floor suburban and tram equipment, where "each cubic centimetre counts".

There are two main development lines:

#### 1) Conventional drive construction

That means standard drive construction with gears and elastic coupling, as used e.g. in the new AGV drive [5]. The drive has proven its performance when boosting the TGV V150's maximum speed to 574.8 kph on 3<sup>rd</sup> of April, 2007. A first series of 25 trains is under delivery for the Italian railway enterprise NTV. ALSTOM markets PMSM in new CITADIS low-floor tramway cars.

#### 2) Gearless drive

Due to the high power-to-weight ratio, PMSM can do away with the heavy gear-box and enable an oil-free drive chain [17]. In the SYNTEGRA drive (150-kW range for underground and trams, Fig. 5.8, [18]) the rotor is fixed to the shaft of the wheel-set. Due to the direct linking of the motors to the carbody, the load transfer is reduced much.

Efficiency of PMSM is claimed to be some 3 % higher than with IM drives, but special precautions must be taken to limit overvoltage when the inverter trips at high speed or to separate a faulty inverter from the motor, as the excitation cannot be terminated. Field weakening for minimising the stator current in the voltage-control region and for constant-voltage operation is performed by impression of demagnetising current components by the inverter; field-oriented control (cf. section VI) can be performed without rotor-position sensors now.



Figure 11. SYNTEGRA bogie with two gearless PMSM.

### C. Medium-Frequency Transformer

To avoid the enormous weight of the 16.7-Hz transformer, a new topology was developed using a medium-frequency (e.g. 5 kHz in the MW-power range). The 15-kV line voltage is rectified by 8 cascaded modules with 6.5-kV IGBTs connected in series, each comprising of an input H-bridge and a (resonantly operated) output half-





The two controller outputs  $k_\psi$  and  $\Delta\chi_\mu$  are processed in block X into the necessary change of the stator-flux space vector in the next sampling period,  $\Delta\Psi_\mu$ , which divided by the sampling period delivers the inner (magnetizing) voltage  $\underline{u}_\mu$ . To that the voltage drop at the stator resistance  $R_s \underline{i}_s$  is added; the result, normalized to  $U_d$ , is the input for the Pulse-Width Modulator

In addition, but not shown here, a very effective Dynamic Field-Weakening is provided in this controller [27]. The Machine Model delivers the model stator currents, which are compared in a Luenberger Observer with the measured values, to compensate parameter and inverter voltage errors [28]. This control is highly dynamic, especially in the field-weakening region, and very robust against input voltage disturbances.

This control has been taken as basis for a speed-sensorless control, doing away with sensitive and damage-prone sensors in the bogie-mounted motors. To that purpose, the mentioned errors are compensated diligently in a feed-forward manner; thus the Luenberger Observer is not needed anymore, and the comparison of measured ( $\underline{i}_{sw}$ ) and modelled ( $\underline{i}_s$ ) stator-current space vectors is used to estimate two other parameters, that is speed and stator resistance [28]. A stator-current DC-component observer suppresses of "unwanted" (parasitic) DC components in stator flux and current, allowing operation with very low frequencies ( $\approx 1\% f_{rated}$ ). A special flux-amplitude management enables speed estimation even at stator frequency zero and thus stopping a train running slowly down and accelerate in the opposite direction, without any speed sensor signal.

[29], [30] report on the successful implementation of a speed-sensorless system, based on the described one, in the new SITRAC Siemens traction control, which has been intensively tested in different light-rail and Metro applications all over the world and is now the standard solution for Siemens Underground and Metro trains.

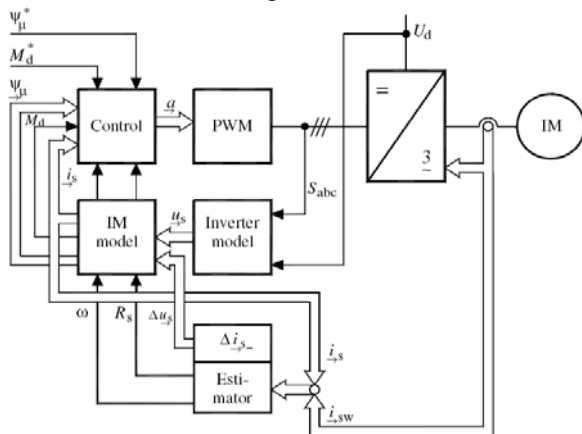


Figure 15. Overall block structure of speed-sensorless ISC.

## VI. RAILWAY POWER-SUPPLY SYSTEMS ISSUES

An overview over the existing four main-line electric power supply systems has been given in section III. This section discusses the influence of power electronics in this field.

### A. DC supply system.

DC supply systems are generally fed by diode rectifiers in 6- or 12-pulse connection. In mass transport systems, own

three-phase medium-voltage (MV) busbars are employed for equalizing peak loads, before connecting to the public mains. Thyristor-equipped rectifiers, feeding back brake power, are in use only with mountain railways. Instead, there is an increasing use of energy storages as rotary storages or Supercaps in substations, to recover brake energy and/or support the supply voltage.

### B. AC 50-Hz supply systems

Very few power-electronic components are in use in 50-Hz systems. Commonly, separate feeding sections are connected to subsequent phases of the three-phase MV grid, to reduce the imbalance of load. The protective insulations have to be crossed with opened main switch. Inverters for reactive power compensation are used only in special situations (Channel Tunnel, Tokyo-Osaka).

### C. AC 16.7-Hz supply systems

Totally different is the situation in the Central European 16.7-Hz grids, which are owned by the infrastructure operators. The catenary is coupled through longitudinally and from track to track, yielding a very high quality of service and enabling a high degree of regeneration of brake power, made possible by the generally employed 4q-C line converters.

Static converters are used more and more, to replace old single-phase power stations and rotary converters, feeding into the interconnected 110-kV transport grid (132 kV in Switzerland). The incentive is similar as with the drives, but here the point is that no supplier is willing to construct new single-phase 16.7-Hz generators anymore, as the market is too small.

The standard solution are single-phase bridge inverters with IGCT (ABB inverter [31]) or press-pack IGBT (Converteam inverters [32]) in three-level NPC technology. Today, the same inverter modules are used in the three-phase 50-Hz side converter, too (Fig. 16).

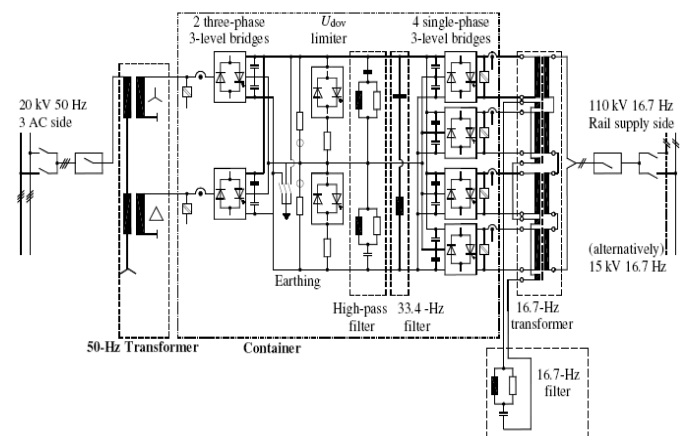


Figure 16. Main circuit diagram of 15-MW standard railway supply converter, using IGCT elements (ABB Switzerland AG).

The output voltages of the 16.7-Hz single-phase inverters are switched synchronously in 3-fold mode, with staggered angles for each inverter; all four are added by two double-stage transformers, with integrated filter tertiary winding. Fig. 17 shows the output voltages of the two bridge branches A and B, and the resultant bridge voltage  $u_2 = u_A - u_B$ , with five levels and six angles per  $90^\circ$ , together with the load current  $i_2$ .

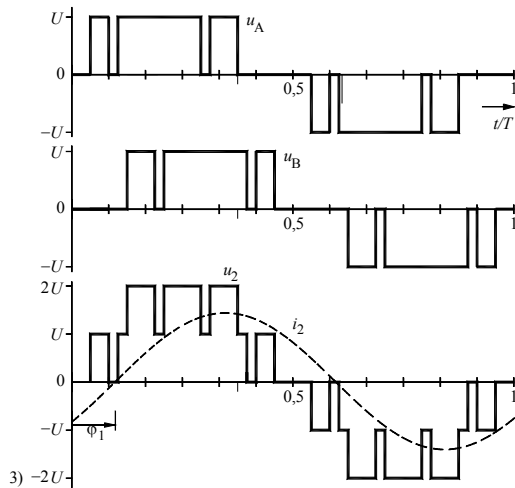


Figure 17. Voltage waveforms of three-level single-phase inverter.

In Datteln, West Germany, at the site of the new E-On 1100-MW hard-coal fired power plant world's largest railway-power supply converter station will be built by ABB. After completion and commissioning in 2011 it will convert up to 413 MW 50-Hz three-phase power into 16.7 Hz. The converter station consists of four converter blocks, which ensure  $n-1$  redundancy due to their overload capability, to absorb a failure of one block and to provide maintenance under full-load [33].

An alternative design is the Modular Multilevel Converter (M<sup>2</sup>LC). Fig. 18 shows a schematic diagram of a railway-intertie converter [34]. Two chains of each  $n$  two-quadrant chopper modules (shown at bottom-right) are connected in series per pole, the storage capacitors  $C$  of which are not fed from exterior voltage supplies, but float more or less freely and have to be equalized by control. There is no common high-voltage dc-link capacitor, the transformers are more or less standard.

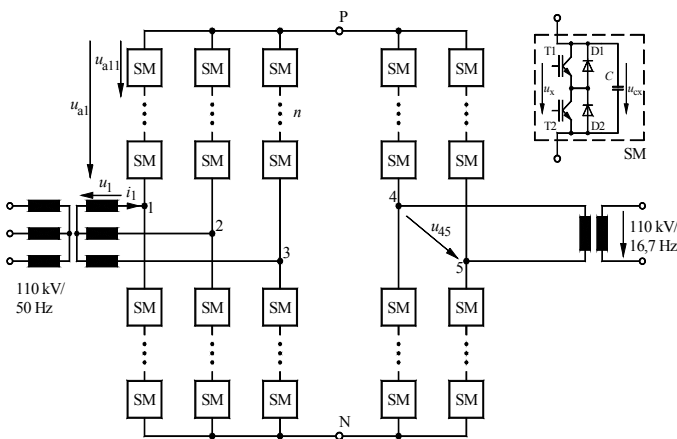


Figure 18. Modular Multilevel Converter three-phase to single-phase.

The output voltage waveform is  $(2n+1)$ -stepped. As the power conversion is performed in single-phase mode, separately for each pole, the capacitors have to take up the single-phase power pulsation, which leads to a considerable voltage ripple, mainly with 16.7 Hz, but resonant circuits are not necessary.

Fig. 19 shows for an example of  $n = 8$  the quantities of the three-phase side. The storage-capacitor voltage variation can be seen clearly in the tops of the module input voltage.

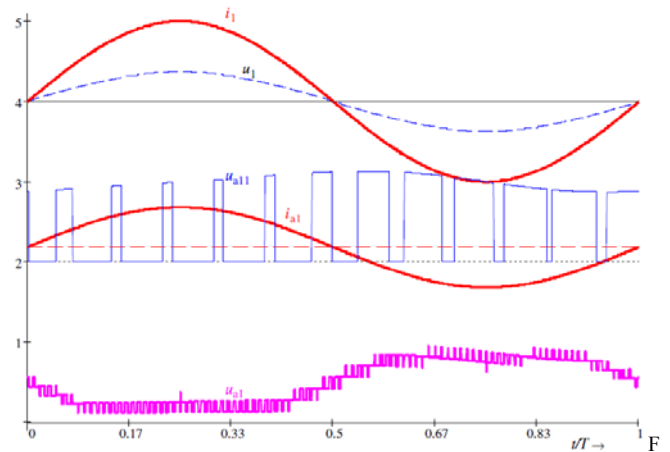


Figure 19. Line voltage  $u_1$  and line current  $i_1$ , module voltage  $u_{a11}$  and arm current  $i_{a1}$ , arm voltage  $u_{a1}$  of a M<sup>2</sup>LC.  $n = 8$ ,  $f_{zmodule} = 600$  Hz.  $u_1$  and  $u_{a11}$  normalized to  $U_{PN, rated}$ ;  $u_{a11}$  to  $U_{PN}/n$ , currents to  $i_{1, rated}$ .

Five plants for the Swedish and two for the German infrastructure company are under contract with Siemens.

#### D. Instability effects in railway grids with power-electronic traction vehicles

Besides the well-known resonances of the railway line voltage, excited by the harmonics of the switching frequency [1], but now enforced by the increased cabling of line feeders in the Alps tunnels and agglomeration areas, new phenomena of instability appear with the massive propagation of power- electronic traction vehicles.

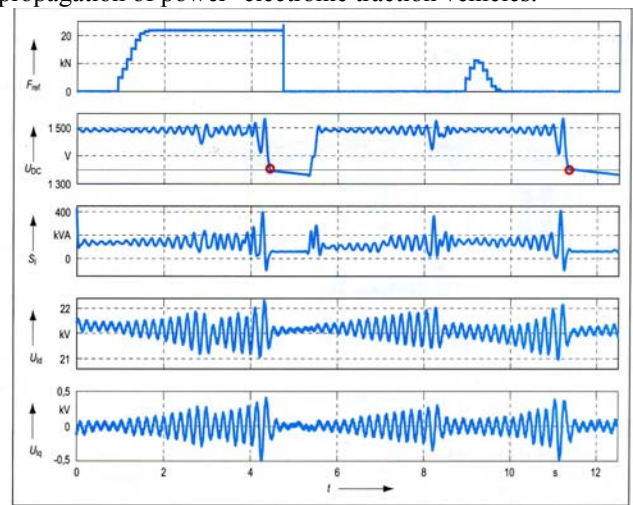


Fig. 1: Low frequency power oscillation measured on Re 450 locomotive at Bonstetten-Wetzwil station on 23rd of September 2004.  
 $F_{ref}$  reference value for traction effort of bogie 1  
 $U_{DC}$  DC link voltage  
 $S_l$  line power  
 $U_{d}$  line voltage amplitude (d-component)  
 $U_{q}$  line voltage phase (q-component)  
 Line values related to vehicle transformer primary side

Figure 20. Low-frequency (2.5 Hz) power oscillations in Switzerland.

In 2007, in Zurich severe grid-power oscillations with very low frequency were observed, where many converter locomotives and only few classic notch-controlled vehicles were in service. In trials these oscillation – which led to the repeated shutdown of the locomotives – were traced back to limit-cycle oscillation between line inductance and dc-link filter capacitor.

Fig. 21 (from [35]) shows a swelling oscillation of line voltage (graph 4) and dc-link voltage (graph 2), which – by dc-link under-voltage at  $t = 4.3$  s and  $9.2$  s – led to the shutoff of the tractive effort (graph 1). A longer line length

or a greater number of vehicles can be exchanged against each others.

In further investigations [36] the decisive influence of the integral gain of the dc-link voltage controller was identified; an advanced multivariable control allows to increase the proportional gain, so that any integral gain can be dispensed with.

## VII. CONCLUSION

The intense competition after deregulation of railways and the new formation of railway industry led to many innovative designs of electric traction vehicles, attractive for the customer and economic to operate, mainly enabled by high-performance induction machines fed by IGBT converters and the high degree of modularity it offers for a broad variety of traction vehicles. Field-oriented control, mainly that in the stator-flux-oriented variant, allows to exploit the increased tractive power stably, at uncertain wheel-rail contact and with vibratory drive chains. Power-electronic converters dominate now the power supply in the Central European 16.7-Hz interconnected grid.

## VIII. ABBREVIATIONS

AGV	Automotrice a Grande Vitesse (High-Speed Railcar)
EMU	Electric Multiple Unit
HST	High-Speed Train
ICE	Inter-City Express
IGBT	Insulated Gate Bipolar Transistor
IGCT	Integrated Gate-Commutated Thyristor
IM	Induction Motor
NPC	Neutral-Point Clamped
PMSM	Permanent-Magnet Synchronous Machine
SMA	SMA Technologie AG, D-34266 Kassel
TGV	Train a Grande Vitesse (High-Speed Train-set)
VSI	Voltage-Source Inverter

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# New Advances and Possibilities in Active Circuit Design

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**Abstract** —Operational amplifiers are important building blocks for analog circuit design. Unfortunately, their limited performance such as bandwidth, slew-rate etc. leads the analog designer to search other possibilities and other building blocks. As a result, new current-mode active building blocks such as operational transconductance amplifiers (OTA), second generation current conveyors (CCII), current-feedback op-amps (CFOA), four terminal floating nullors (FTFN), differential voltage current conveyor (DVCC), differential difference current conveyor (DDCC), third-generation current-conveyor (CCIII), dual X current conveyors (DXCCII), current controlled current conveyors (CCCII) etc. received considerable attention due to their larger dynamic range and wider bandwidth. Employing these new active elements for analog design and using CMOS technology for implementation the circuit designers obtained new possibilities to solve their problems. This work covers new advances and possibilities in the related research area including application on communication, measurement and RF systems.

**Index Terms** — Analog integrated circuits, Analog processing circuits, Circuit simulation, Circuit synthesis, CMOS analog integrated circuits

## I. INTRODUCTION

Digital signal processing is becoming increasingly more powerful while advances in IC technology provides compact efficient implementation of these algorithms in silicon. Although many types of signal processing have indeed moved to digital domain, analog circuits are fundamentally necessary in many of today's complex, high performance systems. This is caused by the reality that naturally occurring signals are analog. Therefore analog circuits act as a bridge between the real world and digital systems [1-4].

At the beginning, operational amplifiers were the unavioded building blocks for analog circuit design. Unfortunately, their limited performance such as bandwidth, slew-rate etc. leads the analog designer to search other possibilities and other building blocks. As a result, new current-mode active building blocks such as operational transconductance amplifiers (OTA), second generation current conveyors (CCII), current-feedback op-amps (CFOA), four terminal floating nullors (FTFN), differential voltage current conveyor (DVCC), differential difference current conveyor (DDCC), third-generation current-conveyor (CCIII), dual X current conveyors (DXCCII), current controlled current conveyors (CCCII) etc. received considerable attention due to their larger dynamic range and wider bandwidth. Employing these new active elements for analog design and using CMOS technology for

implementation the circuit designers obtained new possibilities to solve their problems[5-56]. This work covers new advances and possibilities in the related research area including application on communication, measurement and RF systems.

## II. OTHER TYPE ACTIVE ELEMENTS FOR ANALOG IC DESIGN

Basic amplifier types suitable for analog IC design are shown in TABLE I. Other type active elements are given with their symbols and definition equations in TABLE II.

TABLE I. BASIC ACTIVE ELEMENTS

Class	Gain Function	Operational Property	Name
V-V	$V_o = A_v.(V_1-V_2)$	$A_v \rightarrow \infty$	Operational Amplifier
V-I	$I_o = G_m.(V_1-V_2)$	-	Operational Trans-conductance Amplifier
I-I	$I_o = A_i.(I_1-I_2)$	$A_i \rightarrow \infty$	Current Operational Amplifier
I-V	$V_o = R_m.(I_1-I_2)$	-	Operational Trans-resistance Amplifier

## III. CURRENT-MODE OPERATION

Current mode circuits have received considerable attention due to their potential advantages, such as their inherently wide bandwidth, higher slew-rate, greater linearity, wider dynamic range, simple circuitry and low power consumption [57]. The active devices that have been used to realise current-mode circuits include current conveyors (CCIIs), current feedback op-amps (CFOAs), operational transconductance amplifiers (OTAs) and four-terminal floating nullors (FTFNs).

## IV. OTA: OPERATIONAL TRANSCONDUCTANCE AMPLIFIER

OTA-C structures have attracted considerable attention in recent years because they offer several advantages over conventional op-amp based circuits as well as providing the evaluation of fully integrated circuits in VLSI design with CMOS technology. It is well-known that OTAs provide highly linear electronic tunability of their transconductance (gin) and require just a few or even no resistors for their



TABLE II. OTHER POPULAR ACTIVE ELEMENTS

Name	Symbol	Definition Equations
CC Current Conveyor		$i_y = a \cdot i_x$ $V_x = V_y$ $i_z = \pm i_x$
DOCCII Dual Output Current Conveyor Second Generation		$\begin{bmatrix} v_x \\ i_y \\ i_{z1} \\ i_{z2} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ \pm 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} i_x \\ v_y \\ v_{z1} \\ v_{z2} \end{bmatrix}$
CCCII Current Controlled Current Conveyor		$\begin{bmatrix} I_y \\ V_x \\ I_z \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 1 & R_x & 0 \\ 0 & \pm 1 & 0 \end{bmatrix} \begin{bmatrix} V_y \\ I_x \\ V_z \end{bmatrix}, \quad R_x = \frac{V_T}{2I_o}$
DVCCII Differential Voltage Current Conveyor		$\begin{bmatrix} V_x \\ I_{y1} \\ I_{y2} \\ I_{z1} \\ I_{z2} \end{bmatrix} = \begin{bmatrix} 0 & 1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} I_x \\ V_{y1} \\ V_{y2} \\ V_{z1} \\ V_{z2} \end{bmatrix}$
FTFN Four Terminal Nullor		$I_1 = I_2 = 0 \quad I_{o1} = I_{o2} \quad V_x = V_y$
CDBA Current differencing Buffered amplifier	<p>Fig. 1. a) Circuit symbol of CDBA. b) Equivalent circuit of CDBA.</p>	$\begin{bmatrix} i_z \\ v_w \\ v_p \\ v_n \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & -1 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} v_z \\ i_w \\ i_p \\ i_n \end{bmatrix} \quad (1)$
CDTA Current differencing Transconductance amplifier		$V_p = V_n = 0$ $I_z = \alpha_p I_p - \alpha_n I_n$ $I_{x+} = g V_z$ $I_{x-} = -g V_z$
DXCCII dual X second generation current conveyors		$V_{Xp} = \beta_1 V_y, \quad V_{Xn} = -\beta_2 V_y, \quad I_y = 0,$ $I_{zn} = \alpha_n I_{Xn}, \quad I_{zp} = \alpha_p I_{Xp},$
CFOA Current feedback operational amplifier		$\begin{bmatrix} i_y \\ v_x \\ i_z \\ v_o \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} v_y \\ i_x \\ v_z \end{bmatrix}$

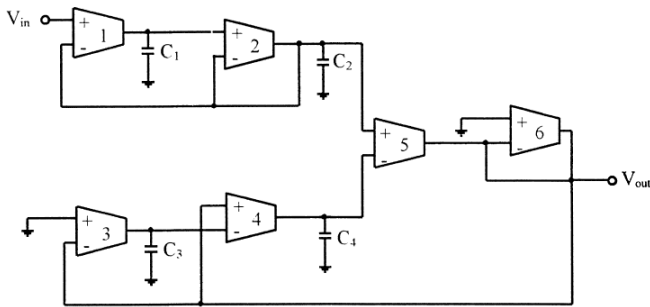
internal circuitry and have more reliable high frequency performance because of the current mode operation which has been established as an important topic in analogue signal processing owing to its advantage over the voltage mode, particularly for higher frequency of operation. Because of these features, the OTAs are increasingly replacing operational amplifiers and in the past few years, a number of OTA-C based filters and oscillators have been reported [5,7,9,12,50,53].

The rapid increasing use of battery-operated portable equipment in application areas such as telecommunications and medical electronics imposes the use of low-power and small-sized circuits realized with VLSI (very large scale integrated) technologies. CMOS (complementary metal-oxide semiconductor) circuits operating in the subthreshold (weak inversion) region introduce a versatile solution for the realization of low-power VLSI building blocks [12]. Circuits needed for processing of biological signals are a

typical and good example of low-power and small-sized building blocks. The main features of biological signals are their low amplitude and low frequency range.

The human electroencephalogram (EEG), which provides a rich picture of the electrical activities of the brain, is one of the most important biological signals [58]. The voltage amplitudes of EEG signals range from about 1–100 mV peak-to-peak at low frequencies (0.5–100 Hz) at the cranial surface.

It is possible to realize low-frequency OTA-C active filters with small capacitance values of the order of 25–400 pF. The circuit technique described is applied to the  $\alpha$  (8–12 Hz),  $\beta$  (13–40 Hz),  $\theta$  (4–8 Hz) and  $\delta$  (1–4 Hz) band filters for EEG signals. Because of small capacitance values the filter circuit is suitable for realization on a single VLSI chip using the CMOS technology, and enables the user to implement the circuit on implantable biotelemetric applications.



Capacitance values for the  $\alpha$ ,  $\beta$ ,  $\theta$  and  $\delta$  bands of the EEG signal

Band	$f_{P1}$ (Hz)	$f_{P2}$ (Hz)	$C_1$ (pF)	$C_2$ (pF)	$C_3$ (pF)	$C_4$ (pF)	$I_B$ (nA)	$G_{\text{diff}}$ (nA/V)
$\alpha$	12	8	166	81	250	122	0.69	8.8
$\beta$	40	13	81	40	250	122	1.125	14.3
$\theta$	8	4	125	61	250	122	0.347	4.4
$\delta$	4	1	62.55	30.6	250	122	0.1	1.1

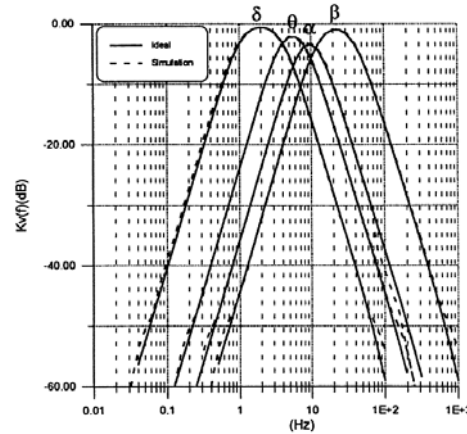


Figure 1. Fourth order OTA-C based EEG filter, frequency responses, capacitance values, biasing currents and OTA transconductance [12].

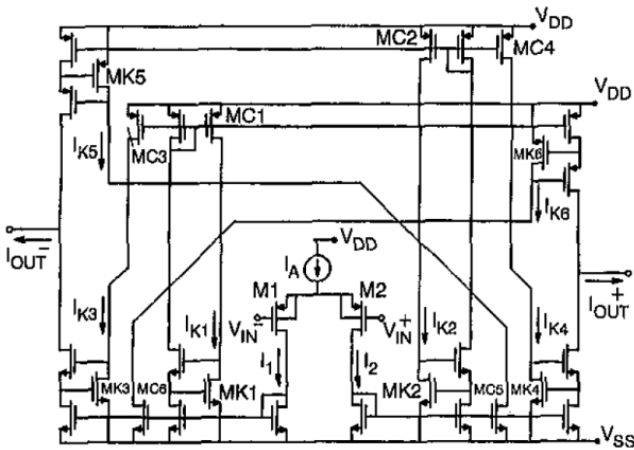


Figure 2. High-performance CMOS OTA realization [14].

The filter chip is fabricated in Turkish Scientific and Technological Council (TUBITAK) YITAL laboratory. Realized filter topology, filter frequency responses, capacitance values, biasing currents and OTA transconductances are shown in Fig.1.

A high performance CMOS dual output OTA realization providing high output impedance values is given in Fig.2.

### V. FTFN: FOUR TERMINAL FLOATING NULLOR

It was demonstrated recently that the FTFN is a more general and flexible building block compared to the active elements mentioned above. This has led to a growing interest in the design of amplifiers, gyrators, inductance simulators, oscillators and current mode filters which use FTFN as the active element [16, 19-21, 24, 59-63, 81]. It is more suitable to exploit FTFN as an active element in current-mode circuit design since it has been shown that an FTFN is the most flexible and versatile building block in active network synthesis [16, 32, 38]. Examples of CMOS FTFN realization are shown in Fig.3. It is also possible to realize FTFN based nonlinear circuits to replace opamp-

based nonlinear structures. A good example from chaotic communication is the following inductorless realization of Chua's circuit using a FTFN- based nonlinear resistor and a FTFN- based inductance simulator illustrated in Fig.4 [32,38].

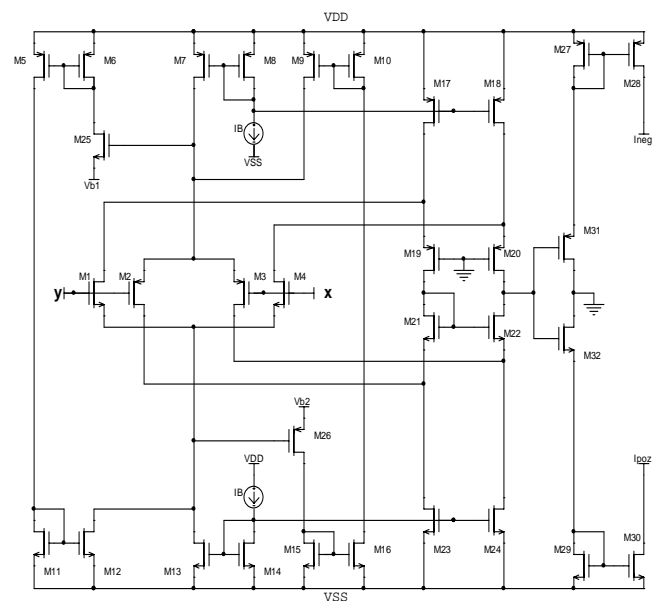
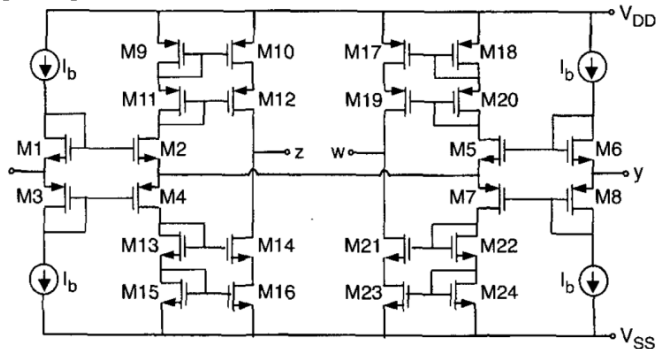


Figure 3. Examples of CMOS FTFN realization [16,32,38,81].

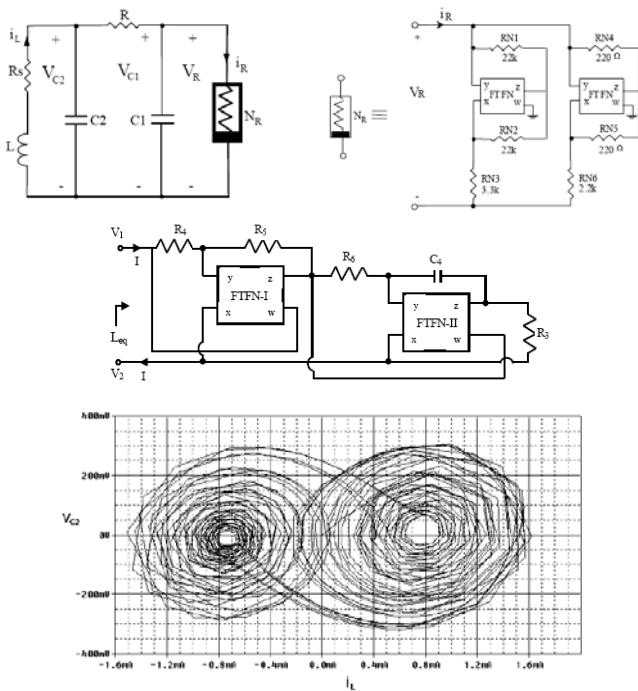


Figure 4. FTFN based realization of Chua's circuit. FTFN realization of nonlinear resistor and inductor, simulation result [38].

The CMOS implementation of Chua's circuit using FTFN based circuit topologies for inductance simulator and Chua's diode provides new possibilities to the designer for the integrated circuit realization of chaotic communication systems.

## VI. OTRA: OPERATIONAL TRANSRESISTANCE AMPLIFIER

The growing demand for mobile communications has led to high level of chip integration and directed research towards the field of high frequency applications. In the new designed circuit topologies for high frequencies, current-mode approach is preferred rather than the traditional voltage-mode structures. OTRA (Operational Transresistance Amplifier), which is commercially available under the name of Norton amplifier has been attracted attention by its advantages in the current-mode circuit design [35,44,64]. Low input and output impedances, a bandwidth independent of the device gain can be considered the main advantageous properties of the OTRA. These commercial realizations don't provide a true virtual ground at the input terminals and they allow the input current to flow in one direction only. In order to remove these disadvantages of the OTRA, some topologies are proposed in the literature [3-8]. But these solutions are both complex structures and do not operate properly at low power supplies like 1.2V if they are realized with sub-micron technologies.

A CMOS realization example of the OTRA is illustrated in Fig. 5.

In today's technology, circuits which use power supplies as 1V, and fabricated in the CMOS 0.09  $\mu\text{m}$  technology can be designed and the process improvement works on the CMOS 65 nm technology with a power supply of 0.9V are still going on. Also CMOS 45 nm technology is available with a power supply of 0.6V.

So for the future design concept the main interest is designing circuitries with low power supplies. This demand

leads designing a high performance CMOS differential OTRA for the current-mode analog systems design. For these reasons, using the STMicroelectronics CMOS 0.13  $\mu\text{m}$  technology, a differential OTRA is designed for 1.2V power supply. This new CMOS differential OTRA topology is characterized by the CADENCE simulation tool and the characteristic results showing its high performance are given. A filter design example is given in Fig.6.

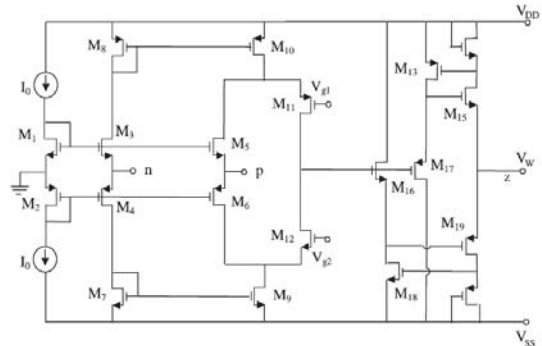


Figure 5. A CMOS implementation of the OTRA [36].

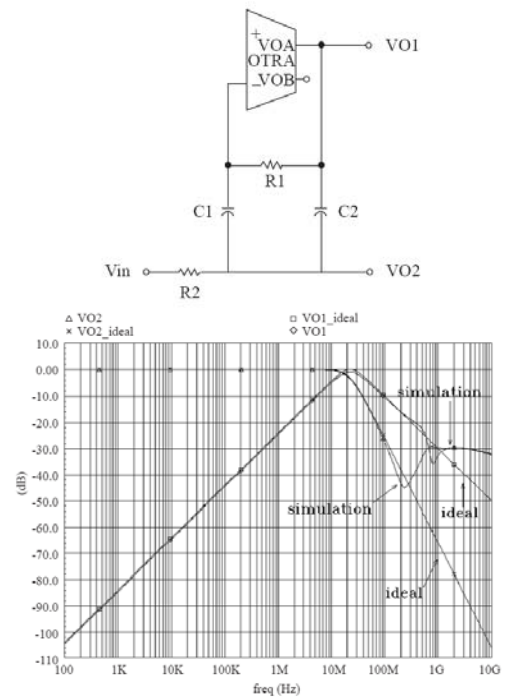


Figure 6. The band pass and low pass filters with OTRA and their frequency responses.

Low pass and band pass filters with single CMOS differential OTRA structures are tested with simulations to verify the theoretical results.

## VII. CFOA: CURRENT-FEEDBACK AMPLIFIER

The conventional operational amplifiers were successfully used over the years for the design of analogue signal processing circuits. The maximum operation frequency of operational amplifier based circuits is determined primarily by the limited gain-bandwidth product and by the slew-rate of the operational amplifier. Since their introduction in 1985 the popularity of current feedback amplifiers has increased considerably as they were found to be able to overcome the limitations arising from conventional operational amplifiers [65-67]. A current feedback amplifier is equivalent to a



plus-type second-generation current conveyor with a voltage buffer, as illustrated in Fig.7. The term current-feedback is used because the error signal entering at the feedback node of the op-amp is in the form of a current and this gives to the amplifier a constant closed loop bandwidth capability [68]. Ideally, the bandwidth of the current-feedback op-amp is independent of the closed loop gain. Therefore the closed loop gain-bandwidth product increases linearly with the closed loop gain. This is a major advantage over the voltage-feedback op-amp architecture, which exhibits a constant GBW [69].

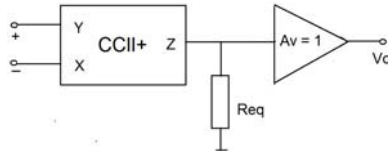


Figure 7. Realization of CFOA employing CCII+ and a voltage buffer.

Since the current feedback operational amplifier (CFOA) has a larger bandwidth and a higher slew-rate than the conventional operational amplifier, analogue signal processing circuits built around the CFOA are expected to operate at higher frequencies than the op-amp based circuits [68].

The current feedback amplifiers are gaining popularity as alternative building blocks for analogue signal processing because of offering the following advantages over the conventional opamps:

- (i) wide bandwidth which is relatively independent of the closed-loop gain
- (ii) very high slew-rate
- (iii) simplicity of realization of various functions with the least possible number of external passive components.

Consequently, there is a growing interest employing CFOAs for the realization of active filters, immittance simulators, single frequency as well as single element controlled variable frequency sinusoidal oscillators and single/multiphase oscillators using CFOA pole.

Recently, several current conveyor based and CFOA based [33,70–72] oscillators are proposed in the literature. The CFOA based topologies offer the following advantage comparing to the current conveyor based circuits. As mentioned above the CFOA has an additional low impedance terminal, which buffers the z terminal of the current conveyor with a unity-gain, thus CFOA based oscillators exhibit low impedance voltage-mode output. CFOA based oscillator circuits are illustrated in Fig.8.

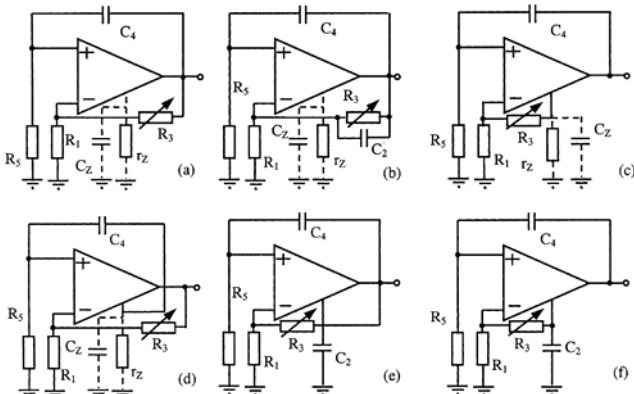


Figure 8. CFOA based oscillator circuits [33].

### VIII. CURRENT CONVEYOR AND ITS DERIVATIVES, CCII, DO-CCII, DVCCII, CCCII, DXCCII

CCII, DO-CCII: The current conveyor is a versatile active element where the current is conveyed between ports at different impedance levels. As an active element it offers several advantages, such as greater linearity and wider bandwidth over the voltage mode counterparts, op-amps [73,74]. Current conveyors find application covering a broad area ranging from filter, oscillator and immittance simulator design to integrators and differentiators. there is growing interest in designing current-mode current conveyor (CC)-based active filters. A current-mode filter theoretically should exhibit high output impedance to enable easy cascadability and to enable additional filter responses by simply connecting the outputs. A current-mode second-order general filter topology employing dual output current conveyors is given in Fig. 9 [28].

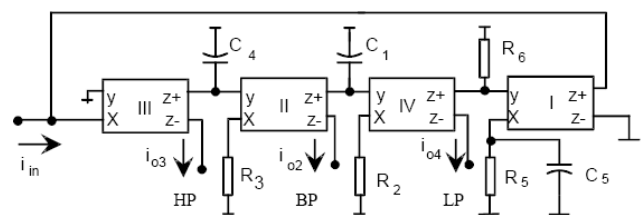


Figure 9. current-mode second-order general filter topology employing dual output current conveyors [28].

CCCI: By using the second generation current controlled conveyor (CCCI) introduced by Fabre *et al.* in 1995 [75], current conveyor applications can be extended to the domain of electronically adjustable functions. Electronic adjustability of the CCCII is attributed to the dependence of the parasitic resistance at port x on the bias current of the current conveyor. Therefore in the recent past, there has been great emphasis on the design of current-mode circuits using current controlled conveyors. A BP filter example and its frequency response are given in Fig.10 [23].

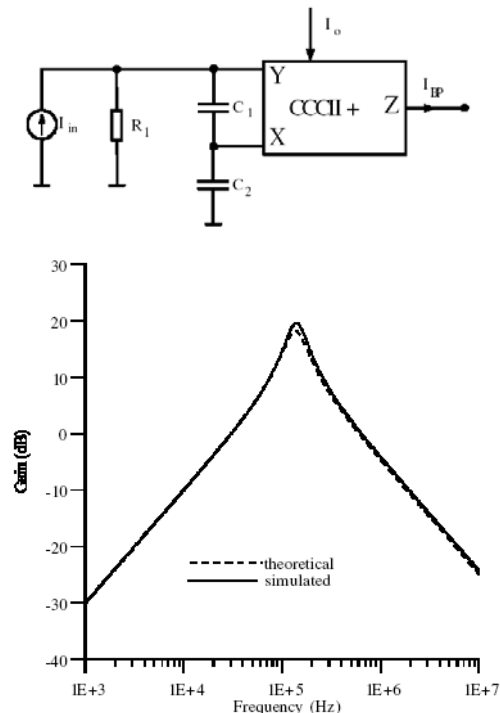


Figure 10. CCCII based filter and its frequency response [23].

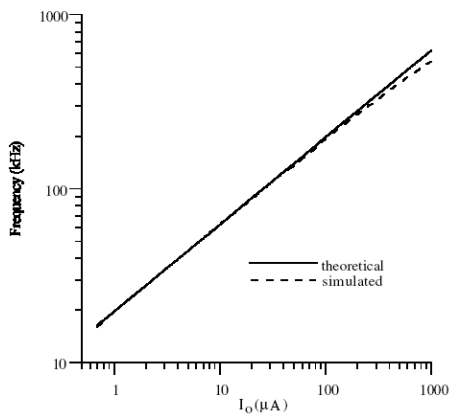


Figure 11. Tuning range of CCCII based filter [23].

**DVCC:** The differential voltage current conveyor DVCC was proposed first by Pal as a modified current conveyor [76] and then developed and realized in CMOS technology by Elwan and Soliman [77]. The DVCC has the advantages of both of the second generation current conveyor (CCII) (such as large signal bandwidth, great linearity, wide dynamic range) and the differential difference amplifier (DDA) (such as high input impedance and arithmetic operation capability) [77]. This element is a versatile building block for applications demanding floating inputs. A CMOS realization of the DVCC, filter design example and the filter response are shown in Fig.12 [40].

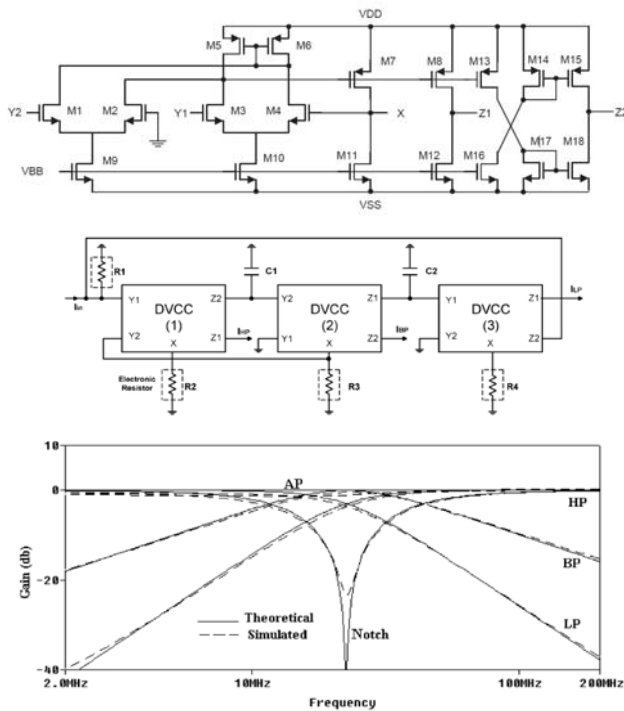


Figure 12. TCMOS realization of DVCC, DVCC based filter topology, frequency response [40].

**DXCC:** The dual X current conveyor DXCCII is conceptually a combination of the regular CCII and the inverting current conveyor (ICCI)[78]. It has two X terminals, namely  $X_p$  (non-inverting X terminal) and  $X_n$  (inverting X terminal). The  $X_p$  and  $X_n$  terminal currents are reflected to the respective Z terminals, namely  $Z_p$  and  $Z_n$ . It is worth emphasizing that, for this device, there is no direct relation between the  $Z_p$  and  $Z_n$  terminal currents. CMOS implementation examples of DXCC are illustrated in Fig.13 [47].

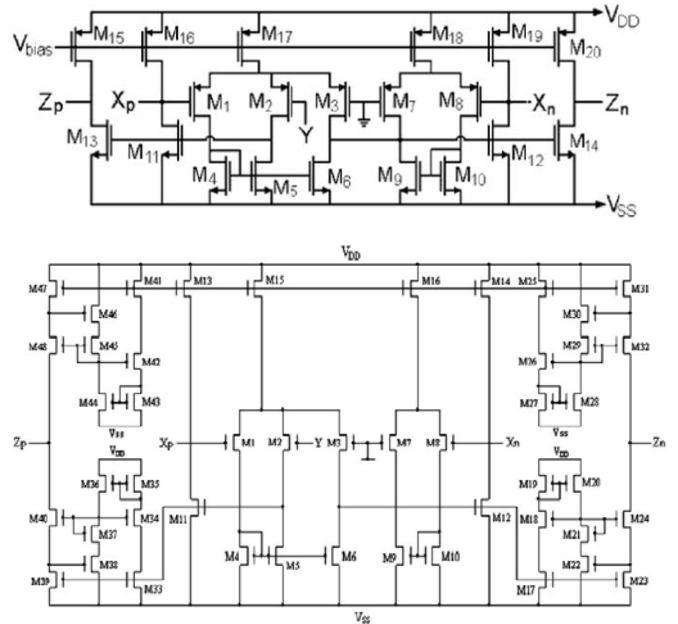


Figure 13. CMOS implementation examples for DXCC [47]

Figure 14 reflects an realization example of FDNR, frequency dependent negative resistor employing DXCC and an application example of ladder-filter constructed with DXCC based FDNRs [47].

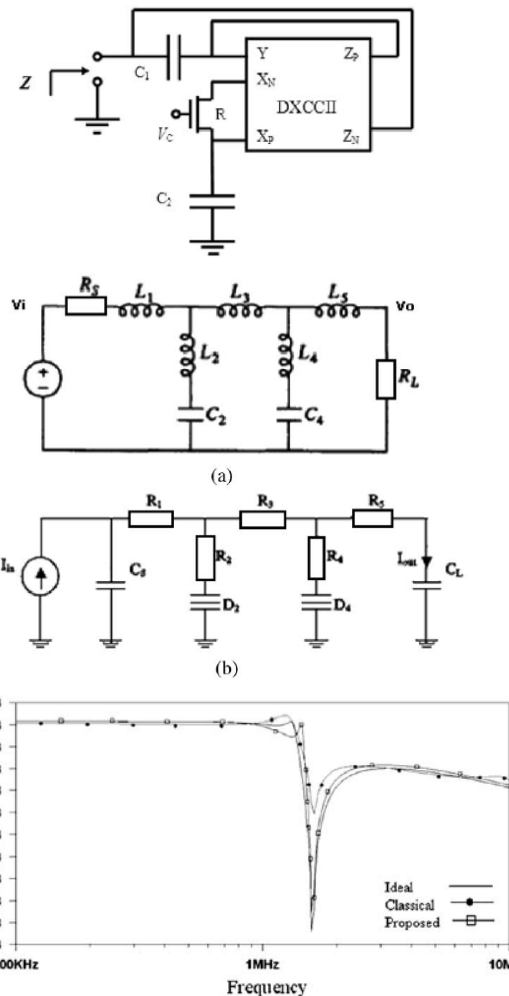


Figure 14. Realization example of FDNR employing DXCC and an application example of ladder-filter constructed with DXCC based FDNRs.

IX. CURRENT DIFFERENCING TRANSCONDUCTANCE AMPLIFIER (CDTA)

A recently reported five terminals active element, proposed by Biolek [79], namely current differencing transconductance amplifier (CDTA) seems to be a versatile component in the realization of a class of analog signal-processing circuits, especially in realization of analog frequency filters. Current differencing transconductance amplifier consists of an input current subtractor and dual output transconductance stage. Improved CMOS realization is shown in Fig. 15. A design example of second-order transadmittance filter is illustrated in Fig.16. Frequency response of the notch filter is illustrated in Fig.17 [51].

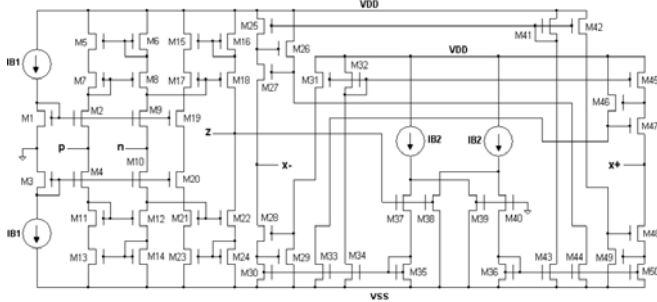


Figure 15. Improved CMOS realization of CDTA [51].

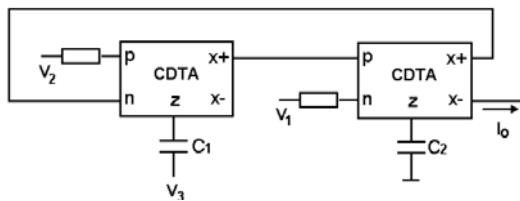


Figure 16. Second order filter realization employing CDTA's [51].

The filter topology realizes LP, BP, HP, BS and AP functions as follows:

- 1)  $V_1 = V_{in}$  and  $V_2 = V_3 = 0$ , LPF
- 2)  $V_2 = V_{in}$  and  $V_1 = V_3 = 0$ , BPF.
- 3)  $V_3 = V_{in}$  and  $V_1 = V_2 = 0$ , HPF.
- 4)  $V_1 = V_3 = V_{in}$  and  $V_2 = 0$ , BSF
- 5)  $V_1 = -V_2 = V_3 = V_{in}$ , APF

Simulated BS frequency response is given in Fig.17.

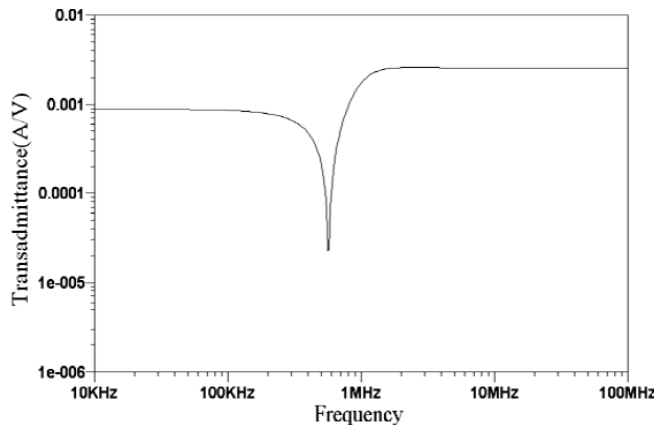


Figure 17. Simulated BS frequency response of CDTA based filter [51].

X. CDBA: CURRENT DIFFERENCING BUFFERED AMPLIFIER

The current differencing buffered amplifier CDBA is a new active element intended to simplify the design of analog signal processing filters [56].  $p$  and  $n$  are input

terminals and  $w$  and  $z$  are output terminals. This element is equivalent to the circuit in Fig. 18, which involves dependent current and voltage sources. current through  $z$ -terminal follows the difference of the currents through  $p$ -terminal and  $n$ -terminal. Moreover, voltage of  $w$ -terminal follows the voltage of  $z$ -terminal. Hence, we name  $w$ -terminal as voltage output. Finally, note that the input terminals  $p$  and  $n$  are internally grounded.

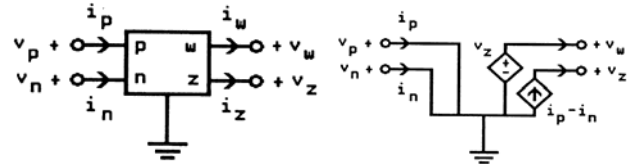


Figure 18. (a) Symbol of CDBA. and its equivalent circuit [56].

A second order general current mode filter topology example is illustrated in Fig. 19. Transfer functions of BP and LP filter functions can be obtained from  $i_{o1}$  and  $i_{o2}$  outputs, respectively.  $i_{o3}$  output yields the sum of HP and BP filter functions. To get the HP function an additional active element is necessary, as shown in Fig.20. Fig.21 and Fig. 22 illustrate the measured frequency responses and the output waveforms, respectively.

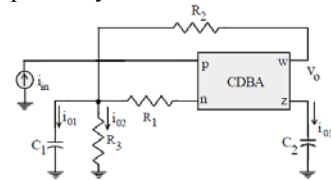


Figure 19. CDBA based general second-order filter topology [31].

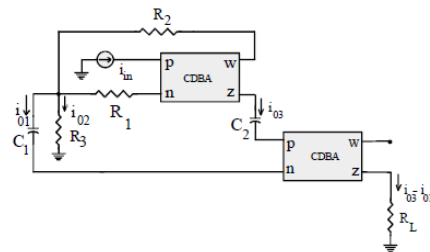


Figure 20. Realization of HP circuit [31].

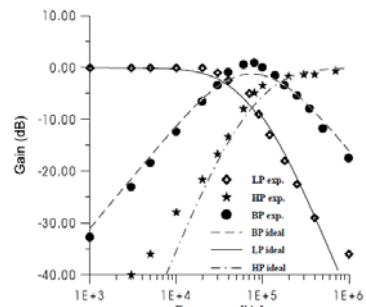


Figure 21. Frequency responses of the filters [31].

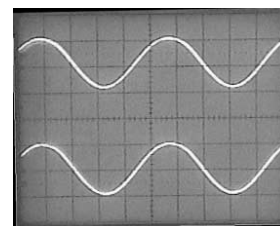


Figure 22. Output waveforms for a sinusoidal 100 kHz input signal of 1000μA and for a load resistance of  $R_L = 10$  kOhm. Lower trace w-output, upper trace z-output (voltages) of CDBA2. Vert.: 10 V/div, Hor.: 2 μs/div.

XI. COA: CURRENT OPERATIONAL AMPLIFIER

Current-mode operational amplifier (COA) is one of the useful current mode integrated building blocks. The main advantage of using COA is its ability to replace with the voltage operational amplifier (VOA) when applying the adjoint network theorem in voltage mode to current mode transformation [80]. A CMOS realization of COA, the step response of the amplifier, COA-based second order filter topologies and high-order BP response obtained by cascading LP and HP sections are given in Figs. 24, 25 and 26, respectively [45].

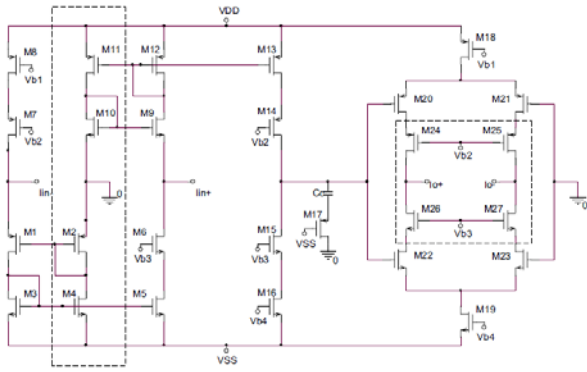


Figure 23. CMOS realization example of COA [45].

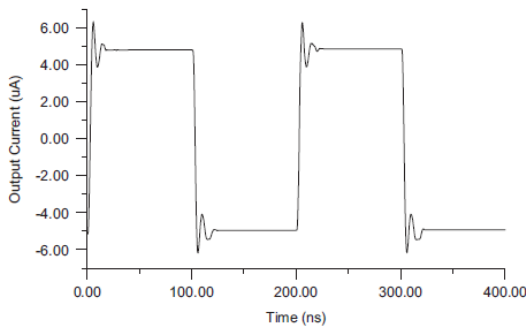


Figure 24. Response of the COA in unity-gain feedback to a  $\pm 5\mu\text{A}$  input step ( $f = 5\text{MHz}$ ).

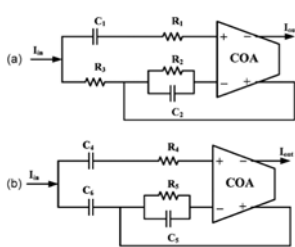


Figure 25. COA-based low-pass filter topology; (b) COA-based high-pass filter topology [45]

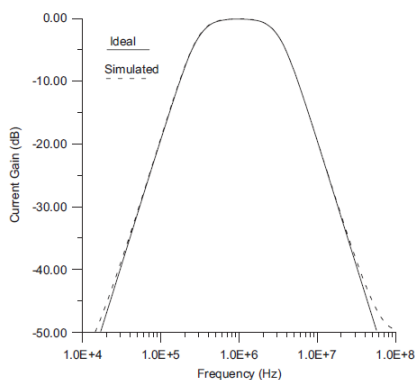


Figure 26. Simulated and ideal band-pass filter responses [45].

XII. CONCLUSION

This work covers new advances and possibilities in the related research area including application on communication, measurement and RF systems. Employing these new active elements for analog applications and using CMOS technology for implementation the circuit designers obtained new possibilities to replace the conventional operational amplifier in their design to solve the problems caused by the limited performance of OPAMPs.

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# Magnetization Dynamics for Nonvolatile Memory Technologies

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*Abstract* — Magnetization dynamics is one of the central issues in the physics of mesoscopic magnetic systems and its understanding is important not only for its evident fundamental interest but also due to the big impact on the information technology, more specifically on magnetic information storage. Magnetic recording is rapidly approaching the nanometer scale as storage densities are projected to increase beyond a terabit per square inch. High volume of data requires higher data transfer rates. These present new challenges and opportunities in nanometer scale materials engineering and in understanding the magnetic properties of nanometer scale magnetic materials. Among the critical issues is the manner and speed which the magnetization direction can be reversed from one stable configuration to another. Also, for the magnetic random access memories (MRAMs) unlike present forms of nonvolatile memories, they must have switching rates and rewrite-ability properties surpassing those of conventional RAMS. This can be achieved only first by understanding and then by controlling the magnetization dynamics of very confined magnetic elements. The presentation will provide a theoretical overview of magnetization reversal phenomenon with applications to nonvolatile memory technologies with emphasis on MRAM, toggle MRAM and Spin Torque Transfer – RAM (STT-RAM).

Leonard SPINU earned a B.S. in Physics from Iasi University in 1991, and a M.S. and Ph.D. in Solid State Physics from Paris-Sud 11 University, Orsay France in 1992 and 1998, respectively. He joined University of New Orleans in 1999 as a research associate in Advanced Materials Research Institute (AMRI) and later in 2002 became a faculty in Department of Physics and AMRI. Currently he is an Associate Professor of Physics and Materials Science and is leading a research group of 3 graduate students, 3 undergraduate students and 1 postdoctoral researcher with experimental and modeling research in nanomagnetism. He once directed at AMRI a DARPA funded project on Advanced Materials for Quantum Computing. His research is currently funded by the National Science Foundation -NSF, Louisiana Board of Regents and Army Research office – Army Research Office-ARO covering subjects as fabrication of high frequency devices based on nanoscale building blocks and characterization of coupled magnetic systems for nonvolatile memory applications. He has more than 100 papers published in peer reviewed journals and he gave more than 30 presentations at major scientific meetings in the field of magnetism and materials science.

*Index Terms* — Nonvolatile Memory Technologies, Magnetization dynamics, mesoscopic magnetic systems, nanometer scale materials, MRAMs, Spin Torque Transfer, STT-RAM

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# Improved Pulses Generated By Piece-wise Parabolic Nyquist Filters

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*Abstract* — This paper presents and investigates a novel approach for constructing a family of ISI-free pulses that shows comparable or better ISI performance in the presence of sampling errors, as compared with some recently proposed pulses. The transfer characteristic of the filter is composed of four parabolic pieces and a flat one. The coordinates of the junction points are determined in order to produce a minimal value of the error probability when the impulse response is sampled with a fixed time offset that accounts for the imperfect synchronization in the receiver. The impulse responses of the new filters show a reduced size first lobe, as compared with other pulses. This results in a decreased value of the error probability when the impulse response is sampled with a fixed time offset, with regard to the ideal sampling moments.

*Index Terms* — improved Nyquist filter, impulse response, error probability

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# Option to Provide the Necessary Feedback for Closed-Loop neuroStimulation

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*Abstract* — Recent developments in Deep Brain Stimulation (DBS) and computer technology have resulted in dramatically new and effective surgical treatments for Parkinson's disease and other movement disorders. From the DBS, by research, the concept has evolved to Closed-Loop neuroStimulation (CLnS) which is the brain target point electric stimulation linked to the patient's body and brain response.

One delicate CLnS difficulty in rising concept functionality is contoured by the need of a feedback source.

Regarding Parkinson's disease, the Subthalamic Nucleus (at target point) generates a modulated signal by Parkinson's tremor. The amplitude values of the modulated signal envelope are far most variable during the day.

By neurostimulating with a signal linked to the differences between maximum and minimum values of modulated signal envelope provided, the patient will receive the exact values required for Parkinson symptoms suppression.

*Index Terms* — Biomedical measurements, Closed-Loop neuroStimulation, Deep Brain Stimulation, DBS process, Neurostimulation

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# Obstacle Avoidance Fuzzy System for Mobile Robot with IR Sensors

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*Abstract* — The goal of this research was to develop a fuzzy obstacle avoidance system for an autonomous mobile robot using IR detection sensors. This paper presents implemented control architecture for behavior-based mobile robot. The mobile robot is able to interact with an unknown environment using a reactive strategy determined by sensory information. Current research in robotics aims to build autonomous and intelligent robots, which can plan its motion in a dynamic environment. Autonomous mobile robots are increasingly used in well structured environment such as warehouses, offices and industries. Fuzzy behavior able to make inferences is well suited for mobile robot navigation because of the uncertainty of the environment. A rule-based fuzzy controller with reactive behavior was implemented and tested on a two wheels mobile robot equipped with infrared sensors to perform collision-free navigation. The experimental results have shown that the proposed architecture provides an efficient and flexible solution for small wheeled mobile robots.

*Index Terms* — Fuzzy system, IR sensors, Mobile robot, Obstacle avoidance

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# Hazardous Events Monitoring System in a Hospital

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*Abstract* — The proposed assignment implies the building of an automated system to monitor a hospital (ASMH), the protection of its patients and its personnel against unwanted events, such as: flooding, gas leaks, breaking and entering, entering the hospital with forbidden objects.

The system uses gas sensors, light sensors, smoke detectors, proximity sensors, flooding sensors and metal detection sensors installed in the points of interest. Sensors are connected to a monitoring system composed of a data acquisition board and a computer. In case of emergency a warning message will be displayed on the monitoring system and through the internet to the authorities. The message contains data about the type of sensor, its location and information about the sensor.

*Index Terms* — monitoring system, automated system to monitor a hospital, ASMH, signal energy, electrical signals, sensor, transducer and transmitter

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# Real-time Communications for Distributed Control Systems

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*Abstract* — Due to the quick evolution of manufacturing processes, the demand for more flexible automation systems is on the rise. To answer these requirements, distributed control architecture based on intelligent drives and CAN networks tends more and more to replace the traditional solutions. CAN was designed and applied in car networking in order to reduce the complexity of the related wiring harnesses. The traditional CAN application technique must be change in order to achieve the real time communication constraints of a distributed control system. In this paper is designed a special purpose scheduler for CAN, which ensure a maximum transmission time for a message. A distributed control system is developed and the proposed scheduler is experimentally validated.

*Index Terms* — Distributed control, delay estimation

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# Design and Comparison of Different Switched Reluctance Machines Topologies for Automotive Applications

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*Abstract* — The present paper approaches the comparative design and analysis of 5 SRM topologies for an EPAS application. Different number of phases and different combination of stator and rotor pole number will be considered, keeping the same main dimensions (outer and inner stator diameter, airgap length, stack length, stator pole height, stator yoke width, rotor pole height) and the same winding per phase (number of turns and wire diameter).

A preliminary sizing of the machine will be carried on, giving the initial geometric data. The key dimensions will be calculated and the winding will be dimensioned. A numerical-based performances analysis will be performed for each case.

*Index Terms* — switched reluctance machine, electrical power assisted steering systems, fault tolerance, conventional and optimization design, numerical field analysis

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# The VSB-01 Portable System for Monitoring Environmental Conditions

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*Abstract* — Static devices for environmental parameters measurements are widely encountered in practice. Considering the advantages of mobile devices for environmental parameters measurements such as: low cost, possibility to perform measurements in different areas approximately in the same time, we focus our work on the design and the implementation of such mobile device. Further development of our device (VSB-01) is also discussed in this paper.

*Index Terms* — airpollution, amplifier, capacitor, microphone, sensors

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# Computer Program for Studying the Operation of Gas Turbine Plants

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*Abstract* — The combined heat and power plants equipped with gas turbines under various alternatives give an attractive solution in ensuring the heat demand under the form of hot water for the residential areas of urban settlements. Recovering the heat contained in the burning gas for steam generation and hot water supply represents the reason for using these plants in cogeneration applications. Lately, it comes out that there are used more and more average and small power solutions placed at consumers which have high performances. The paper presents a computer program made in the Visual Basic language for studying the operation of gas turbine plants. With this program, people are able to perform the thermodynamic analysis of gas turbine plants both in nominal and not nominal working regimes. The paper also presents the results of using the program for a 24 MW gas turbine.

*Index Terms* — thermal power generation, computer aided software engineering, power system modelling, turbines

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# Kalman Filter Based Tracking in an Video Surveillance System

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*Abstract* — In this paper we have developed a Matlab/Simulink based model for monitoring a contact in a video surveillance sequence. For the segmentation process and correct identification of a contact in a surveillance video, we have used the Horn-Schunck optical flow algorithm. The position and the behavior of the correctly detected contact were monitored with the help of the traditional Kalman filter. After that we have compared the results obtained from the optical flow method with the ones obtained from the Kalman filter, and we show the correct functionality of the Kalman filter based tracking. The tests were performed using video data taken with the help of a fix camera. The tested algorithm has shown promising results.

*Index Terms* — Video Surveillance System, Optical Flow, Kalman Filtering, Image Processing, Tracking

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# A Fuzzy Approach Regarding the Optimization of Statistical Process Control through Shewhart Control Charts

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*Abstract* — The main goal of most organizations, no matter of their nature, object or size, is to be competitive as possible on the market, a crucial factor in ensuring a long operating duration. Unfortunately, the appearance of variation is a very bad and undesirable thing that determine a decrease in the companies productivity. Managing and providing a better view competitiveness can not be given unless we use some statistic models. This models' variables follow closely each step of the process. If in the past years the issue of the control managing of a process wasn't seriously taken into consideration, today more things like more pretentious customers or the growth of the competitiveness level on the products and logistics market, made almost all companies to hire people, especially for the control of the quality. They have to check not only the final products but also the intermediate stages of the process. The aim of this paper is to realize a fuzzy approach based on statistical control techniques concerning on Shewhart control charts. The relationship between statistical process control and fuzzy modeling is a very researched field because the sensitivity of the fuzzy systems is an important advantage in quality analysis of the production process.

*Index Terms* — statistical process control, control charts, special causes, fuzzy logic, double warning limit

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# Multiagent System for Robotic Vision System

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*Abstract* — In this paper we present a robot vision mechanism for a multiagent robotic systems for controlling the behavior of the agents. For implementing this vision mechanism we consider the fuzzy technology which is very versatile in this situation. This mechanism offers the surveillance of the entire set of robots and contributes to their behavior.

*Index Terms* — cooperative systems, intelligent control, robot vision systems, fuzzy control, fuzzy neural network

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# The use of Fuzzy Modelling Regarding the Assurance of Environmental Protection

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*Abstract* — Environmental pollution has become a more stringently problem in recent years. The main reasons for increase of the environmental pollution at the level of the whole planet are represented by the increase of garbage amount and by the lack of special places for it's storage, the increased number of the toxic substances used in many fields of science that leads to a continuous pollution of the breathing air. Finally, another important reason for the increase of environmental pollution is represented by the continuously development of the technology that has a disastrous effect for natural ecosystems. Because of these factors, measures were taken in order to avoid disasters, like the dramatic decreased of ozone layer. Based on some fuzzy modelling, the aim of this paper is to design a system that ensure a better protection of the environment.

*Index Terms* — fuzzy networks, sustainable development, importance-performance analysis, hybrid system

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# Experience-Based Design and Simulations of a Fuzzy Control System for Cardiovascular Variables

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*Abstract* — The control of physiological variables presents specific challenges, mainly due to the highly nonlinear, complex behavior of biological systems. Cardiovascular system stands as a clear example, with critical situations when control is desirable and troublesome in the same time. This paper presents a fuzzy control strategy for two cardiovascular variables, blood pressure and cardiac output, by automatic infusion of two commonly used drugs, sodium nitroprusside and dopamine, respectively. The fuzzy controllers proposed here are PI type, designed by experience, with rules established by interviewing a physician. Simulations are possible, making use of a mathematical model describing the effects of drugs infusion rates on controlled variables. The main goal is achieving the normal and safe values within a reasonable time period. Furthermore, cost reduction by minimized drug consumption and shortened period of clinical treatment is part of the main issues which motivate automation.

*Index Terms* — Cardiovascular system, Drug delivery systems, Fuzzy control, Fuzzy systems, Physiological variables control

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# A Methodology of Power Demand Prediction

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*Abstract* — The end use consumers of energy conversion, transport and distribution determine market demand of energy. This should be balanced by the offer provided by producers in the energy system.

Ensuring the balance between demand and supply in electricity is a complex process of dynamic nature and requires a strict balance of electrical power at each moment for ensuring a stable energy system, since the electricity can not be stored. This balancing of supply and demand of energy must be fulfilled both technically and economically. Recording activity and energy consumption parameters that depend on them is followed by a prediction of consumption and an analysis of the results to improve the final information quality.

The study presented in the paper focuses on predicting trends in energy consumption, holding for database real-time readings of energy consumption related to a calendar year, filed for a distribution operator. The chosen prediction mechanism is the simple linear regression method, since the only variable that was considered is the history of consumption. The presented prediction methodology uses the regression instrument of Excel running linear regression analysis using least squares method to find a line that corresponds to a set of observations.

It was intended that the indexes of quality of energy consumption trend is as good as they can be in order to increase the chances that forecast made to adequately reflect the future actual data and the maximum percentage error is as small as it can be.

*Index Terms* — load curves, power demand, prediction, statistical indicators, trend

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# μC/OS-II Real Time Kernel port for Cirrus Logic EP93xx platform

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*Abstract* — Real-time systems are a key element for applications where deadlines must be satisfied. The absence of a time constraint in a hard real-time system can cause severe material damage or even life threatening scenarios. This is why the system designer's task is to make proper selection of an embedded operating system that can meet these demands.

*Index Terms* — μC/OS-II, hard real-time/soft real-time, embedded system, EP9302, real-time scheduling, operating system

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# Analytic Method for Determination of the Amplitude-Phase Transmission Errors Between Selsyns

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*Abstract* — The paper presents an analytic method capable to evaluate the transmission errors between two selsyns. The method is validated by experimental tests. The system created in this way allows the determination of small errors, like seconds in the transmission of the angular position between a transmitter selsyn and a receiver selsyn.

*Index Terms* — analytic method, selsyn, transmission errors

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# Thunderstorms as Interactive Component of Global Ecodynamics

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*Abstract* — An analysis of thunderstorms is realized to understand the interrelation between different atmospheric processes and to assess the tendencies in generation of the atmospherics. In the paper an analytical description of natural atmosphere-electric discharges is given which can be used in modeling of these atmospheric phenomena.

*Index Terms* — Global ecodynamics, natural disasters, monitoring systems, ecology, atmospheric chemistry

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# Analysis and Simulation of Unbalanced Systems

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*Abstract* — The correct appreciation of the unbalanced states requires the establishment of the ranges and availability situations for the multitude of known calculus relations. Their verification, as well as the calibration and testing of the virtual instruments, dedicated to the unbalanced states, are demanding the unbalanced phasors system simulation.

The method of the equal modulus and equal, consecutive, phases, developed in the paper, presents the next advantage: the phasors system is defined in comparison with only one variable, this one being the phase between two consecutive phasors. The analytically study on a definition range of this variable ( $2\pi$ ), emphasizes the complete covering of the unbalanced state indicators range, so any type of asymmetries may be described.

The corresponding functions for the symmetrical components, as well as for the unbalanced state indicators, as the dissymmetry and asymmetry coefficients, are analytically and graphically presented.

The approaching of the inverse problem affords the unbalanced states identification, which have to fulfill certain unbalance degrees, expressed through the precised dissymmetry and asymmetry coefficients.

*Index Terms* — calculus relations of the unbalanced states, Stokvis-Fortescue theorem, phasors system, dissymmetry and asymmetry coefficients, iterative calculus method

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# Hybrid Electric Vehicle Experimental Model with CAN Network Real Time Control

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*Abstract* — In this paper an experimental model with a distributed control system of a hybrid electrical vehicle is presented. A communication CAN network of high speed (1 Mbps) assures a distributed control of the all components. The modeling and the control of different operating regimes are realized on an experimental test-bench of a hybrid electrical vehicle. The experimental results concerning the variations of the mains variables (currents, torques, speeds) are presented.

*Index Terms* — CAN network, experimental model, hybrid electrical vehicle, real time control

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# The Iterative Algorithm of Tuning Controllers to the Model Object with Advance and Inertia Second Order

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*Abstract* — This paper proposes an iterative algorithm of tuning the typical controllers PI, PID to the model objects with advance and inertia (second order). The proposed algorithm is using the maximal stability degree method for tuning controllers. As the result of this study the algorithm of tuning controllers and the procedure of determining the system's performance in dependence of maximal stability value is proposed.

*Index Terms* — the iterative algorithm, the maximal stability degree method, tuning of controllers

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# Tuning Controllers in the Multiple-Loop Feedback Control System to the Objects with Inertia, Time Delay and Non Minimal Phase

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*Abstract* — This paper proposes a tuning algorithm of linear controllers P, PI, PID in the multiple-loop feedback control systems. The control object consists of two subprocesses, which are described by the dynamical models with inertia (first and second order), time delay and non minimal phase. The controllers in the internal contour and in the external contour tuning use the maximal stability degree method. P and PI controllers are used in the internal contour and P, PI, PID controllers are used in the external contour.

*Index Terms* — multiple-loop feedback control system, tuning of controllers, internal contour, external contour, non minimal phase, time delay, maximal stability degree method

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# Fuzzy Model for Sustainability Assurance Related to Environmental Protection

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*Abstract* — This paper aims to build a system based on fuzzy models that can be implemented in the assessment of ecological systems, to determine appropriate methods of action for reducing adverse effects on environmental and implicit the population. It is noted that this subject of research represent a high interest current in the world. In situations difficult to approach methods with modeling conventional, are proposed as a reliable alternative pathways to fuzzy logic-based modeling. Information systems may determine, based on data supplied by the beneficiary (government agencies, local authorities, economic agents), appropriate methods of action for reducing adverse effects on industry, agriculture, forestry, water management and human settlements. Fuzzy algorithms in this field is new, and presume definition, clear delimitation and the analysis of the system which performing the tasks specified.

*Index Terms* — environmental assessment, fuzzy model, sustainability

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# Mechanical-electrical Optoisolator Transducer with current-to-frequency Conversion

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*Abstract* — A novel design for a mechanical-electrical transducer is presented in this article along with the preliminary testing of the transducer prototype. By using a Polaroid optocoupler as the motion sensor, this device combines the transducer feature to convert mechanical signals to electrical ones with the optoisolator feature of galvanic separation between two voltage modules. Signal conditioning circuit is a current-to-frequency converter, while the obtained signals are logically compatible and can be processed by a microprocessor. The device is aimed for application in the areas of automation and mechatronics.

*Index Terms* — Current-to-frequency conversion, Optical polarization, Optoelectronics, Polaroid optocoupler, Transducer

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# A Short Survey on Applications of Rough Sets Theory in Power Engineering

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*Abstract* — Rough Set theory has proved to be an adequate technique in imperfect data analysis, which has found interesting extensions and various applications. It can be regarded as complementary to other theories that deal with imperfect knowledge, such as Bayesian inference or fuzzy sets. The paper presents some Rough Set Theory applications in electrical power engineering.

*Index Terms* — data management, information systems, knowledge based systems, knowledge engineering, power systems

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# Middleware Based Model of Heterogeneous Systems for SCADA Distributed Applications

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*Abstract* — Infrastructure underlying the distributed information systems is heterogeneous and very complex. Middleware allows the development of distributed information systems, without knowing the functioning details of an infrastructure, by its abstracting. An essential issue on designing such systems is represented by choosing the middleware technologies. An architectural model of a SCADA system based on middleware is proposed in this paper. This system is formed of servers that centralize data and clients, which receive information from a server, thus allowing the chart displaying of such information. All these components own a specific functionality and can exchange information, by means of a middleware bus. A middleware bus signifies a software bus, where more middleware technologies can coexist.

*Index Terms* — middleware, SCADA, client-server technology, heterogeneous system, distributed system

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# Time of Arrival Based on Chirp Pulses as a means to Perform Localization in IEEE 802.15.4a Wireless Sensor Networks

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*Abstract* — This paper introduces the technology Time of Arrival (TOA) based on chirp pulses (according to IEEE 802.15.4a) as a means to perform localization in Wireless Sensor Networks (WSN's) active at 2.4 GHz. Advantages and disadvantages of the technology are discussed and act as a guideline for improving localization accuracy. Tests concerning TOA are performed by means of the location engine of Nanotron. Adapting this engine leads to improved localization results. It is shown that TOA measurements are susceptible to reflections and dynamic environments.

*Index Terms* — Chirp Pulses, Localization, RF, Time of Arrival, Wireless Sensor Networks

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# A New Family of CSK Signals

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*Abstract* — A new family of CSK pulses with good spectral properties defined on the time interval  $[-T, T]$  is proposed and its spectral properties are investigated. Imposing the condition that the signals of this family should exhibit a large number of derivatives which are continuous and equal to zero at the ends of the time interval  $[-T, T]$ , the expressions of Fourier transforms of the component signals are deduced. So, exact analytical formulae for the power spectral densities (p.s.d.) of these signals can be derived.

The asymptotic decay rate of the envelope of power spectral density can be made small enough. These pulses are of interest in digital communications and in particular in wireless transmissions, as the intercarrier interference is diminished.

*Index Terms* — Digital communication, digital modulation Fourier transforms, frequency domain analysis, pulse analysis

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# Some Useful Properties of STBC Codes for Residential Applications

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*Abstract* — Main drawbacks of Wi-Fi home networks are inadequate range and coverage. A way to improve both of them is the use of transmit diversity, which also increases network throughput by finding paths with highest data rates and avoiding signal paths that induces packet errors and retransmissions. The main idea of the transmit diversity is the use of space-time coding (STC) techniques that spread the same information across different antennas at the transmitter in order to obtain a transmit diversity. This paper aims to study coherent space-time block codes to estimate the channel coefficients in the presence of flat fading. It focuses on the popular transmit diversity scheme of Alamouti assuming a flat fading Rayleigh multipath channel and BPSK and QPSK modulation schemes.

*Index Terms* — Space Time Coding, Transmit Diversity, Zero Forcing algorithm, Alamouti code, channel state information at the receiver

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# Spectral Analysis of Three Miller-like Codes

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*Abstract* — There is a variety of codes that derive from the delay modulation or Miller code. Unlike Miller code, some are D.C.-constrained. They are also RLL (*Run-Length Limited*). A thorough spectral analysis of three DC-free Miller-like codes was performed. The derived coding factor formulae and the p.s.d. representations confirm the D.C.-free properties of this code.

*Index Terms* — Codes, Digital filters, Markov processes, Spectral analysis

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# A New Evolutionary Approach for Base Station Transmitter Placement

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*Abstract* — In the designing of a mobile phone network (cellular network) it is very important to place the base stations optimally for the cheaper and better customer service. As this is a NP-hard optimization problem so heuristic approach is a good choice. We propose a new evolutionary approach to solve base station transmitter location (BST-L) problem. The algorithm is designed to meet two main objectives. One is to cover all demands of the service area and another is minimizing the interference as much as possible. In our proposed approach, we use only mutation operator. To make the process efficient random and problem-specific knowledge is used in the operator.

*Index Terms* — BST-L problem, Cellular Systems, Evolutionary Algorithm, interference minimization, mutation

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# An Optimization of Gaussian UWB Pulses

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*Abstract* — UWB is a new interesting technology for wireless communications. It can replace traditionally carrier-based radio transmission by pulse-based transmission using ultrawide band frequency but at a very low energy. An important aspect of research in this domain is to find a pulse with an optimal shape, whose power spectral density respects and best fits emission limitation mask imposed by FCC.

In this paper we review common used Gaussian pulses and its derivatives and the influence of shape factor, finding an optimal specific value for each derivative. Next, we search to obtain possible better pulse shapes as linear combinations of Gaussian derivatives. Older studies refer in one case to the same shape factor for all derivatives and in other case to higher factor for first derivative and smaller shape factors for subsequent derivatives.

Our new idea is to use Gaussian derivatives, each with its specific optimal shape factor and to use a "trial and error" algorithm to obtain a linear combination pulse with better performance.

*Index Terms* — Gaussian Monocycle; Shape factor; Trial and error; UWB; Wireless LAN

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# The Impacts of Temperature on PMD and CD Dispersions during High Speed Optical Communications

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*Abstract* — The widespread use of optical fiber networks caused expansion of 10 Gbits and 40 Gbits transmission. These new requirements caused negative impacts like chromatic dispersion (CD) and polarization mode dispersion (PMD). CD and PMD must be measured more accurately and frequently than ever. In this paper both dispersions for 25 km long singlemod fiber in temperature range from -35°C to 60°C were measured and discussed. Results show that there is a high impact of temperature on measured parameters of the dispersions.

*Index Terms* — Optical fibers, optical fiber dispersion, chromatic dispersion, polarization mode dispersion

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# New High Performance Deterministic Interleavers for Turbo Codes

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*Abstract* — Turbo codes offer extraordinary performance, especially at low signal to noise ratios, due to a low multiplicity of low weight code words. The interleaver design is critical in order to realize an apparent randomness of the code, thus further enhancing its performance, especially for short block frames. This paper presents four new deterministic interleaver design methods, that lead to highly performing turbo coding systems, namely the block-spread, the block-backtracking and their variations the linearly-spread and linearly-backtracking interleavers. The design methods are explained in depth and the results are compared against some of the most wide-spread turbo code interleavers. Furthermore, the selection method of the generator polynomials used in the simulations is explained.

*Index Terms* — Channel coding, Concatenated coding, Deterministic algorithms, Error correction coding, interleaved coding

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# A Comparative Approach on WiMax and LTE Technologies

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*Abstract* — Wireless industry continues to change at very high speeds, tending to use the equipment more easily and safely and with a connection speed that tends to be higher and higher. Users of 3G wireless networks are looking forward to the launch of the new 4G standard. WiMax and LTE technologies are the main competitors in the mobile communication domain. This paper is a comparative study based on the first two level layers of the most innovative wireless and mobile technologies (WiMax and LTE), a technical comparative overview the parameters performances and the vulnerabilities of this technologies.

*Index Terms* — 4G, Comparative Approaches, LTE, WiMax, Wireless

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# Data Communications in an HPC Hybrid Cluster and Performance Evaluation

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*Abstract* — The need for powerful computing systems is more present than ever in the today scientific (and not only) environment. Cluster systems built with general purpose processors (a trend that caught in the previous years) are superseded today by platforms built around specialized multicore processors, capable of processing massive amounts of arithmetic operations, usually from the field of graphic accelerators (GPU). These units are specifically created to manage intensive operations so they are the logical choice for this purpose. IBM took this step by creating a platform that uses a multicore accelerator CPU (Cell BE) for the HPC operations, managed by nodes with a more traditional architecture, with general purpose CPUs (AMD Opteron). This hybrid approach toward HPC is successful, even if the application deployment and software development can pose a certain degree of difficulty.

*Index Terms* — data communications, networking, Cell BE, hybrid cluster, k-means, RISC architecture, speedup

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# LTE eNodeB Demonstrator with Real and Simulated Interfaces

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*Abstract* — The difference between a simulator and an emulator resides in the feature of emulation to replace the functions of real equipment in operability conditions. When it comes to networking, the main distinction between simulation and emulation can be confined to the option of connectivity with real interfaces that makes possible intercommunication between virtualized and real network elements. The paper describes a method of integrating real interfaces to communicate with simulation modules of OMNeT++ environment. The case study presented is oriented towards Long Term Evolution eNodeB functionality emulation.

*Index Terms* — Communication system software, Discrete event simulation, Internetworking, Long Term Evolution, Network interfaces, Mobile Data Communications, Simulation software

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# Simulation of LTE Signaling

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*Abstract*—This article aims to present a simulation and emulation software that was developed to simulate the call flows of a LTE (Long Term Evolution) network. LTE is the latest Mobile Telecommunications technology being currently in development and testing phase. The simulator can be used as an e-Learning software, for teaching the procedures and phases of different LTE scenarios. Call flows can be visualized through the simulation panel, where signaling messages can be run continuously or step-by-step, for the purpose of detailed analysis. The simulator has the capability to generate real signaling packets that are being sent to a virtual loopback adapter and captured / dissected using the Wireshark software. In this way a whole simulation environment is created that is very useful for teaching the latest mobile telecommunications technology, the LTE (Long Term Evolution) system.

*Index Terms* —Communication Systems, Communication Standards, Communication System Signaling, Computer networks, Protocols

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# BPEL Implementation of QoS-based Management in Multi-modal Mobile Communications

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*Abstract* — The authors consider the concept of "partial handover" of connections in multi-modal mobile packet communications. This is based on the idea of a partial transfer - not a total one, e.g. 10%-90% - of the connection. Maintaining at a minimum level the channel with reduced QoS (Quality of Service), with drastically reduced energy consumption, has also the advantage of keeping a signaling path - practically "on common channel". It is also useful to simply restore the preponderance of a channel if its QoS increases significantly, without the complications of restarting the radio link, even if this could be internally triggered, at the mobile terminal level, through the other path which is still active. The proof-of-concept is oriented on a 3G/WLAN multi-modal communication, with a binary decision, based on the QoS calculus - as double weighted sum of performance parameters - on a path and its comparison with a threshold value or with the "cost function" of the QoS on the other path.

*Index Terms* — Communication Systems, Communication Standards, Communication System Signaling, Computer networks, Protocols

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# Eigenvalue Characterization of the Sum Capacity of Multi-User MIMO Multiple Access Channels

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*Abstract* — In this paper, we focus on the sum capacity of finite size multi-user MIMO wireless communication on Gaussian MAC. We provide an eigenvalue analysis of the mutual information of Gaussian MAC channels under transmitter power constraint based on the majorization theory.

A single user MIMO system is characterized by a channel matrix, which is a linear transformation of the input information in the presence of the Gaussian noise. By writing the mutual information in terms of the eigenvalues of this channel matrix, we give an eigenvalue characterization of MIMO MAC channels from both information theoretic, and from wireless communication perspective.

We will extend our eigenvalue approach given in a previous paper for a discrete memoryless channel (DMC) with invertible channel matrix, to a single user Gaussian MIMO system, and after that we will generalize the results to the multiuser MIMO MAC wireless communication systems.

We derived a fundamental inequality among the eigenvalues of the transmitter covariance matrix, which will assure its convergence in a finite number of steps toward the optimal solution. By using this inequality and again the majorization theory we give a proof of the Telatar conjecture under the above conditions. The complete proof including the general case when the channel matrix is random and partial CSI is available at the transmitter is under investigation right now.

*Index Terms* — Sum Capacity, Multi-User MIMO, MAC wireless communication systems, Multiple Access Channels, discrete memoryless channel, DMC

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# Assigning Connection Sources in Large-Scale Circuits Multilevel Decomposition

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*Abstract* — Diakoptic analysis means the decomposition of the large-scale circuits into sub-circuits which can be singly and in the same time analyzed. In order to preserve the voltages and currents from the initial circuit, connection sources to the sub-circuits are assigned. In this paper, an efficient connection sources assignment algorithm is presented.

*Index Terms* — large-scale circuits decomposition, diakoptic analysis concept

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# The Modeling of the Heating Resistors in Transient Regime

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*Abstract* — The present paper presents an applicative solution of mathematical modeling and simulation for resistive heating elements. A frequently problem, which appears during the use of these ovens, is the rapid aging who leads to the break down of the heating resistors. This model allows the simulation of the transient self-heating regime, as well as of the continuous heating regime. To verify this, the authors have realized a more complex model of an electrical oven with resistors, which integrates the models of the heating resistors as subsystems. The paper presents a part of the simulation results and the conclusions generated by their analysis.

*Index Terms* — circuit simulation, electric heating, electrothermal effects, industrial power systems, system modeling

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# Electronic Devices for Determining the Working Length in Root Canal Therapy

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*Abstract* — The paper refers to the modern electronic devices that can be used for determining the working length in a root canal, in the most important phase of endodontic treatment. It briefly presents new generations of such devices and some possible developments based on electronic improvements

*IndexTerms* — root canal, endodontic therapy, electrical impedance

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# A Study in Binary Relations for Logic Algebra Functions

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*Abstract* — Solving the Design for Test (DFT) problem for digital circuits (DC) requires conducting complex studies of the phenomena situated at the boundaries of scientific directions, such as Digital Signal Theory, Logic and Boolean Algebra, DC Analysis and Synthesis, DC Design Fundamentals, Testing Algorithms Design, Relational Models, DC Testing. Half a century, from the moment the DFT for DC problem was raised, no concluding results were obtained, which confirms the necessity for introducing a new DFT paradigm, based on existence principles found in nature. Creating this new DFT paradigm requires the analysis, design and usage of certain binary relations between logical functions (LF), determined on the same definition domain as binary arguments tuples. This fact leads to the creation of new elementary structures and the development of a modern and efficient DFT theory.

The present study originality lies in performing for the first time an exhaustive analysis of the logic functions binary relations in logic algebra, with the purpose of highlighting their properties, important for formalizing synthesis algorithms and elaborating the concepts for digital structures and for the indispensable know-how regarding obtaining an adequate solution for the Designed for Test problem for digital circuits.

*Index Terms* — complement, duality, equivalence, partial complement

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# Study of Binary Relations of Boolean Algebra Functions

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*Abstract* — In the process of digital circuits (DC) design, the logical functions (LF) are initially represented in the boolean simple base (BSB) of the Boolean algebra (BA), which allows checking the correctness of representing the minimal shape of the LF and the absence of the logical redundancy. The usage of only 3 boolean operators - AND, OR, NOT, is imposing some restrictions in the process of synthesis, because any LF must be represented by the operator AND or OR: without negations, with negation only at the input or only at the output, with negations on the arbitrary connexions. Also, the main resources of minimization (for example, Karnaugh diagrams) and the synthesis procedures are most developed for the LF represented in BSB. The originality of this study stands in making, for the first time, a complete analysis and a mathematical description of the logical binary relations (LBR) of the LF in the BA. The purpose of the paper is to detect the LBR properties which are important for formalizing the synthesizing algorithms, the concepts development, digital structures and know-how needed to obtain adequate solutions of the design problem and to increase the technological efficiency of making the actual integrated circuits.

*Index Terms* — boolean algebra, technological efficiency, equivalence, complement, duality

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# Electrical and Switching Parameters of Amorphous Chalcogenide Glassy Semiconductors $\text{Cu}_5(\text{AsSe}_{1.4}\text{I}_{0.2})_{95}$

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*Abstract* — The subject of this paper is experimental determination of electrical and switching parameters at different temperatures of amorphous chalcogenide glassy semiconductors  $\text{Cu}_5(\text{AsSe}_{1.4}\text{I}_{0.2})_{95}$ . It was shown that amorphous semiconductors from the system  $\text{Cu}_x(\text{AsSe}_{1.4}\text{I}_{0.2})_{100-x}$  have relatively high electrical resistance and expressed memory and threshold switching nonlinear effect, so that they have great potential for applications in electronics and optoelectronics. On switching parameters of the realized switching component a great impact have next properties of the active amorphous semiconductor: values of the activation energy, electrical conductivity, softening and working temperature. It has been found that this glass has current-controlled negative resistance (CCNR) switching characteristic with memory and high values of switching threshold fields.

*Index Terms* — electronic switching systems, amorphous semiconductors, nonlinear systems, semiconductor device doping, semiconductor device measurements

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# Analysis of Coupled Oscillators through a Series RLC Network

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*Abstract* — Voltage controlled oscillators are present in almost every digital communication system. Thus, coupled microwave oscillators are the subject of intense research activities. Recently, they are used to control the phase in microwave antenna arrays as an alternative to electronic beam steering methods. Researches are made so that a particular phase shift can be obtained by choosing the free-running frequencies of the oscillators in the array. In this paper, we have analyzed, in different ways, in time domain and also in frequency domain, the phase shift between output voltages of each pair of coupled oscillators and also, the behavior of multiple coupled oscillators

*Index Terms* — phase shift, synchronization, oscillator, microwave, VCO

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# Sensitivity and Tolerance Analysis in Analog Circuits Using Symbolic Methods

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*Abstract* — The paper is focused on a new and practical approach to perform sensitivity and tolerance analysis of analog lumped circuits. Any linear circuit can contain passive elements, magnetically coupled inductors, excess elements, and any type of independent and controlled sources. Special strategies based on symbolic methods are used in order to reduce the computational effort and to minimize the numerical errors in the automatic design of these circuits. As part of this process, a new, modern, reliable and easy-to-use software tool for sensitivity and tolerance analysis has been developed, as a useful and valuable support for research and design engineers.

*Index Terms* — sensitivity, tolerance analysis, analog circuit, symbolic methods, software tools

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# HDL Implementation from Petri Nets Description

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*Abstract* — This paper describes the digital systems synthesis based on direct mapping of Petri nets model into FPGA circuit. A design flow that includes the specification of the system using Synchronous Petri Nets, verification of the behavioral properties of the model, generation of the mathematical model of Hard Petri Nets (HPN), used for automatic generation of the AHDL code is described. The direct mapping approach avoids algorithmic complexity inherent in logic synthesis based on state encoding and substantially reduces the design time and cost. The method used for modeling and implementation of the digital systems was validated using MAX+PLUS II design environment.

*Index Terms* — AHDL, digital system, direct mapping, FPGA, MAX+PLUS II, Hard Petri Nets

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# Induction Motor Control with Predicted Maximum Electromagnetic Torque and Speed

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*Abstract* — The paper presents a new control of an induction motor, based on the indirect rotor – flux – oriented control (IRFOC). The control circuit ensures an independent electromagnetic torque control, which limits its maximum value to a predicted one. The torque predicted values are dependent on the external parameters of the induction motor and overrides the speed control. The proposed system can be implemented in various applications constrained by mechanical or physical factors, which require variable torque and speed.

*Index Terms* — Indirect Rotor – Flux – Oriented Control (IRFOC), induction motor, rotor, torque, speed

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# Temperature Influence on Conversion Efficiency in the Case of Photovoltaic Cells

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*Abstract* — The following paper presents concisely the operation principles of photovoltaic cells and their main parameters. The heat transfer process for a PV cell is described in order to analyze the PV cell temperature variation during operation. The aim of the paper is investigating temperature's influence on the conversion efficiency of solar energy into electricity. Temperature measurements have been done to provide PV cells' actual operation temperatures and also to ease an analysis on their effect on the conversion process.

*Index Terms* — Conversion efficiency, Photovoltaic cells, Photovoltaic cell thermal factors, Solar energy, Solar radiation

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# GPRS Controlled System for Monitoring and Control of Well Sites

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*Abstract* — In this paper a hardware realization of a water well monitoring and control system is presented. The system for water level monitoring is built of several field units which measure the water levels, and gives full control over the well site pumps using inverters and other actuators. Measured data from field units are gathered and analyzed by central data analyzer. This gives user insight into the amount of water in a certain area and other parameters measured by field units. Organization of system allows operator to make remote commands to well site actuators instantly. Using modern technology it is possible to implement algorithm of self diagnostics and calibration and to use measured data to make model of underground water behavior for monitored area.

*Index Terms* — GPRS, remote control, well monitoring, water level measurement

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# Cordless Seismic Data Acquisition System

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*Abstract* — Seismic methods are based on capturing of artificially generated seismic waves that are reflected on different ground layers. Seismic waves are captured using geophones, electro-mechanical sensors specially designed for geophysical exploration. This paper suggests a new system for data acquisition, based on ARM microcontroller, GSM/GPS module used in wireless network, internet technologies and a work station. This seismic system, comparing to older cable realizations, will cost less, greatly reduce the logistics effort, and reduce manpower required to conduct a seismic survey. In this paper are presented hardware and software realization, communicating network and results of data acquisition.

*Index Terms* — seismic method, geophone, AD conversion, GSM

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# Borehole Orientation Sensor - Hardware Realization

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*Abstract* — Borehole measurement systems are used for measuring various parameters in gas, oil, water and other borehole exploration facilities. Measurement methods include the use of various sophisticated tools that are descended into boreholes. Nowadays there is a strong tendency of replacing analogue with digital well logging tools. In this article a hardware realization of one such digital device is presented.

This device is designed to provide orientation information in borehole logging and directional drilling applications. To fully determine the orientation of a borehole two parameters have to be known: the angle between the borehole axis and true vertical (inclination) and the angle of its departure from magnetic North (azimuth). These values are vital for determining the trajectory and depth of a well, and are also very important as preliminary parameters in other geophysical measurements. The orientation module combines a 3-axis magnetometer and 2-axis MEMS accelerometer, analog and digital support circuits, microprocessor and algorithms required for orientation angles computation. The measured values are transmitted to the surface over a mono cable in real time. For this purpose a special digital communication protocol has been developed. In this article the general principles of operation are briefly explained and details related to the electronic design and realization are given.

*Index Terms* — azimuth, borehole, inclination, orientation, sensor

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# Indoor Inter-Robot Distance Measurement in Collaborative Systems

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*Abstract* — This paper focuses on the problem of autonomous distance calculation between multiple mobile robots in collaborative systems. We propose and discuss two distinct methods, specifically developed under important design and functional constraints, such as the speed of operation, accuracy, energy and cost efficiency. Moreover, the methods are designed to be applied to indoor robotic systems and are independent of fixed landmarks. The measurement results, performed on the CORE-TX case study, show that the proposed solutions meet the design requirements previously specified.

*Index Terms* — collaborative system, distance measurement, indoor communication, mobile robots, Sonar

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# On Resonance Charts of Piezoelectric Ceramics of Perovskite-Type, in Microwave Range

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*Abstract* — Determination of the electrical resonance positions on frequency scale for the multicomponent materials is a necessity for the a correct exploitation of the material in the HF range, where multiple resonances are present. We have used for resonances determination a microwave simulation method, applied for a class of piezoelectric ceramics of perovskite-type: the  $K_xNa_{1-x}NbO_3$  and  $(1-y)K_{0.5}Na_{0.5}NbO_3-ySrTiO_3$  crystals. Results were obtained in the frequency domain of 0.3–30 GHz. Structural interpretations and conclusions about geometrical and physical resonances determined for the material samples are available. The links between the resonances of the electrical displacement and the internal structure of the material samples were illustrated by resonance charts and commented as well. Geometrical parameters of the constituents (ionic radii, ion relative distances, average grains dimensions, etc.) and also the physical parameters (ions nature, concentration factors, phase transitions, polarization mechanisms, etc.) influence the resonance charts and can be also coordinated for resonances modification.

*Index Terms* — electrical resonances, finite element method, microwave range, piezoelectric ceramics, structural simulation

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# Finite State Machine Design and VHDL Coding Techniques

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*Abstract* — The first part of paper discusses a variety of issues regarding finite state machine design using the hardware description language. VHDL coding styles and different methodologies are presented. Our study of FSM focuses on the modeling issues such as VHDL coding style, state encoding schemes and Mealy or Moore machines. Our discussion is limited to the synchronous FSM, in which the transition is controlled by a clock signal and can occur only at the triggering edge of the clock.

The second part contains a worked example of a model that detects a unique pattern from a serial input data stream and generates a ‘1’ value to output whenever the sequence ‘10’ occurs. The string detector is modeled at the RTL level in VHDL and Verilog, for comparison purposes.

The last part of this paper presents a view on VHDL and Verilog languages by comparing their similarities and contrasting their difference.

*Index Terms* — VHDL code, Verilog code, finite state machine, Mealy machine, Moore machine, modeling issues, state encoding

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# Synchronous Overmodulation Control of Cascaded Inverters for Photovoltaic Application

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*Abstract* — Novel method of synchronized pulsewidth modulation (PWM) has been disseminated for control of cascaded (dual) inverters of photovoltaic installation with relatively low DC-voltages of two insulated photovoltaic panels. Control regimes are characterized by overmodulation control modes of two inverters in this case. Algorithms of synchronized PWM provide continuous voltage synchronization both in each inverter and in the load in the overmodulation control zone of inverters. Special attention has been given to analysis of operation of photovoltaic systems with different DC-voltages of two strings of photovoltaic panels. Results of simulations present a behavior of dual-inverter photovoltaic system with two discontinuous and one combined versions of synchronized PWM.

*Index Terms* — Photovoltaic power systems, Pulse width modulated power converters, Synchronization, Voltage control

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# Hysteresis Modelling of Soft Magnetic Materials using LabVIEW Programs

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*Abstract* — The paper deals with an analytical model for hysteresis cycle representation. The hysteresis curve is decomposed in a series of arcs of circles and segments of lines. Each arc of circle or segment of line is expressed using analytical geometry as a function of some given parameters or calculated ones. The easiness of the model proposed is given by the small amount of input data needed to represent the hysteresis cycle in a satisfactory way. Using an inverse mapping function from major hysteresis branches the minor cycles, reversal curve of the first kind or curve of first magnetization can be obtained. Finally a comparison between the measured data and modelled ones was made.

*Index Terms* — soft magnetic materials, modeling, magnetic hysteresis

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# Performance Evaluations and Comparative Electromagnetic Compatibility Measurements on Compact Fluorescent Lamps

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*Abstract* — When compared to standard incandescent light bulbs, compact fluorescent lights (CFL) provide multiple benefits and give much longer lifetime and lower power consumption. Available in a wide variety of models and various wattages, efficiency types and prices, nowadays CFL seems to successfully replace the use of incandescent lights. On the other hand, disadvantages like dangerous electromagnetic pollutions and harmful ultraviolet radiations made CFLs the subject of many debates concerning their performances.

Several electromagnetic compatibility measurements were performed in order to point out the high level of radiated and conducted disturbances of CFLs. The first set of experiments were made in the frequency band of 1 MHz to 500 MHz, and then reduced to 1 MHz - 300 MHz, 1 MHz - 100 MHz and 1 Hz - 50 KHz frequency intervals. Comparative EMC measurements on three different compact fluorescent bulbs were made using a specific test setup (as described in chapter 4). For CFL emissions testing, we used an anechoic chamber, which is a shielded enclosure with radio absorbing materials on ceiling and walls. The results obtained were then compared to the CISPR22 standard limits.

*Index Terms* — anechoic chamber, common mode current, compact fluorescent lamp (CFL), electromagnetic compatibility (EMC), electronic ballast

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# Analysis of Beamforming in Phased Antenna Arrays

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*Abstract* — In this paper the beamforming and radiation pattern of various linear and planar phased antenna arrays configurations are presented. They are intended for use in indoor location estimation and wireless process monitoring applications based on the determining of direction-of-arrival (DOA) of radio signals by measuring the angle-of-arrival (AOA). Beamforming and the steering of antenna's lobes are obtained via a linear phase taper applied between antenna array elements, which provides a relatively simple design. Various antenna array configurations are studied using numerical simulations in order to obtain an optimal beamforming necessary for indoor localization and scanning systems.

*Index Terms* — Antenna arrays, Antenna radiation patterns, Array signal processing, Phased arrays, Indoor localization

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# Audio Source Localization, using a Network of Embedded Devices

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*Abstract* — In this paper, a problem of audio source localization is solved, using a network of embedded devices. The intensive computing procedures (such as the crosscorrelation functions) are performed by the embedded devices, which have enough speed and memory for this task. A central computer computes the position in a fast procedure, using the data transmitted by the network nodes, and plays the role of operator interface. The paper also contains the description of the embedded devices, which are designed and manufactured by the authors. They prove to be suited for this kind of application, as they perform fast computation and require low power and small space for installing.

*Index Terms* — audio source, direction of arrival (DoA), embedded devices, position measurement, sensor network

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# Modeling of Ferrite Common Mode Chokes for EMI Suppression in LTCC Technology

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*Abstract* — In this paper, proposed structure of ferrite common mode choke for suppression of conductive electromagnetic interference (EMI) will be presented. The proposed chokes can be realized in low temperature co-fired ceramics (LTCC) technology. LTCC technology is chosen in order to achieve better performance passive components, with excellent thermal and high frequency electrical performance. Proposed choke consists of two highly conductive multilayer quadratic spiral type inductors, embedded in ferrite material 40012. To obtain the optimal design of choke, the simulation tool ILCMC for calculation of insertion loss of common mode choke is used. Simulations have been conducted for different geometrical dimensions of structure of the common mode choke using software tool ILCMC. Insertion losses of proposed components are calculated and compared.

*Index Terms* — Electromagnetic interference, ferrite devices, loss, modeling, simulation software

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# Embedded System for Start of ICE with Hybrid Battery-Super-capacitor Sources

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*Abstract* — In automotive starting systems the demand for efficient use of energy and environmental protection lead to the use of supercapacitors in combination with traditional starter batteries. The main advantages of the hybrid battery – supercapacitor systems are extended life span of batteries, lower capacity, lower weight and volume as well as meeting the environmental regulations. The control of internal combustion engine (ICE) starting systems values the specific gains in terms of energy of lead acid batteries and supercapacitors, having as final performance indicator the available starter power.

The paper presents the control strategies of the hybrid battery – supercapacitor system using a microcontroller which efficiently distributes the energy transfer among sources (battery, supercapacitor, alternator) and specific loads (starter and other energy consumers).

*Index Terms* —Algorithms, alternator, battery chargers, microcontroller, starting

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# Magnetic Properties of Two-Dimensional (2D) Heisenberg Lattices as Good Candidates for Spintronic Junctions

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*Abstract* — In this article we briefly recall a theoretical treatment previously published [1] and concerning the magnetic properties of 2D square lattices composed of  $(2N+1)^2$  classical spins isotropically coupled between first-nearest neighbors (i.e., showing Heisenberg couplings). Indeed these layers are good candidates for spintronic junctions. In the thermodynamic limit ( $N \rightarrow +\infty$ ), we recall that (i) a very simple closed-form expression may be derived for the zero-field partition function  $Z_N(0)$ , (ii) the spin correlation vanishes in the zero-field limit i.e., there is no remnant magnetization, except at  $T=0$  K; (iii) the spin-spin correlation is described by a correlation path confined inside a correlation domain (Theorem 1). As a result a general closed-form expression may be respectively derived for the spin-spin correlation between any two lattice sites (Theorem 2) and for the susceptibility, without any approximation. We finally test previous experimental fits and we show that the use of a truncated expansion for the susceptibility was totally justified.

*Index Terms* — spintronics, classical spins, Heisenberg couplings, magnetic properties, quantum theory

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# A New Hybrid Genetic Algorithm for the District Heating Network Problem

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*Abstract* — In this paper we propose a new hybrid genetic algorithm with an adaptive fitness function to solve the problem of extending district heating networks, related to the prize-collecting Steiner tree problem. The multi-criterial optimization is achieved by means of weighting the profit and costs, depending on the application. The experimental results showed that the algorithm works well for small and sparse graphs and the running time is reasonable.

*Index Terms* — Water heating systems, Genetic algorithms, Optimization methods, Trees (graphs), Prize-collecting Steiner tree

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# Information Security Policy in the Distributed Computer Systems

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*Abstract* — In the paper are presented the general principles of the information security policy in the computer systems. The main components of the security policy, implemented in accordance with the requirements of the modern standards, are described in detail.

The model of the security policy for the distributed computer systems is suggested. The potential threats to the safety of the computer systems and the main rules of the security policy for administrating in the distributed computer systems are formulated and substantiated, using the suggested model.

The suggested model for the access control of the subjects to objects in the distributed computer systems allows formalize an important component of the information security system.

*Index Terms* — distributed computer systems, information security, model, security policy

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# Analysis and Determination of Risk Factors Leading to Preterm Birth Using Data Mining Techniques in

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*Abstract* — This paper aims to present a method of analysis a real medical dataset using Data Mining techniques. The method determines the risk factors leading to preterm birth and also analysis the quality in obstetrics. As language and development environment for statistical computation we used the R system. The purpose of this study is to highlight the influence of certain factors for premature birth by using graphics created in R.

The method further, applied on a sample of Romanian births, shows that various socio-demographic, anthropometric, behavioral and medical factors act interconnected in a direct manner on the risk of premature births. To prove this statement we wanted a partitioning based on similarities between the attributes that may be risk factors. We also classified attributes that may represent risk factors according to the type of birth: term or preterm. The results will be outlined with graphics obtained by applying data exploration algorithms.

*Index Terms* — Clustering, Data Mining, Heatmap, Preterm birth, R programming language

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# Embarking on the road of Intrusion Detection, with Erlang

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*Abstract* — Intrusion detection techniques are indispensable for the security infrastructure in order to detect threats before damage is produced. New methods have been conceived using advanced mechanisms, some of them biologically inspired, but all need some kind of information fusion. To be able to deploy these methods some functionalities are required for processing the huge amount of data passing through the network environment. We have been developing such functionalities in the Erlang programming language and are presenting them in this paper.

*Index Terms* — Computer maintenance, Computer network reliability, Computer network security, Functional programming, Network operating systems

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# Argumentative Support for Structured HACCP Plans

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*Abstract* — This research presents an argumentation based decision support system for implementing the Hazard Analysis at Critical Control Points (HACCP) standard in food industry. Our analysis starts by identifying the adequate technical instrumentation needed for supporting different aspects of the HACCP system. An integrated architectural solution is presented. The framework is built around concept maps and it exploits the integration of ontologies with argumentation theory by using the Argument Interchange Format ontology.

*Index Terms* — decision support systems, food industry, description logic, argumentation, supply chains

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# Applied Realization of Neural Network and Neurolike Parallel-Hierarchical System Based on GPGPU

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*Abstract* — The paper considers main aspects and features of applied realization of neural network and neurolike parallel-hierarchical systems based on GPGPU technologies. The research performs the analysis of the architecture of modern GPU and models of GPU parallel programming, as well as considers ways of GPU programs optimization for parallel computing in general-purpose parallel-hierarchical systems, proposed as a networking model of neurolike scheme of information processing. On the basis of research performed and results obtained software modules are offered for realization at CPU and GPU of large-scale neural and neurolike parallel-hierarchical networks of different topologies.

*Index Terms* — parallel-hierarchical neurolike systems, neural networks, parallel computing, GPGPU, video card programming, image processing, forecast

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# An Ontological Approach to Legal Literature for Improving Legal Knowledge Dissemination

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*Abstract* — We present an ontological approach to the legal literature for translating sources of law into information accessible to people both with and without a legal education. To improve the quality of the legislative language and to facilitate legal experts and citizens in accessing the legislation we propose to use legal ontologies. In this sense we show the roles of two legal ontologies: the LKIF-core Ontology and the Lex-is Ontology in improving the dissemination of legal knowledge.

*Index Terms* — computer science, information retrieval, knowledge based systems, knowledge representation, problem-solving

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# Architectural Views for Designing Relationships in Distributed Systems

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*Abstract* — The paper studies the detailed design of relationships between concepts, taking into account four architectural views: logical, process, implementation and deployment. The classical patterns, applied if one considers the conceptual relationships from the logical view, are not enough for distributed applications, because the related elements may pertain to different computing nodes. More criteria should be used for the detailed design, like the technology used for communication paths - e.g. for Service Oriented Architectures - or the rights to modify the subsystems containing the related elements - if the distributed system is based on composing reusable assets. Moreover, the object oriented approach may need to be leveraged by a design based on aspects, for grasping crosscutting issues.

*Index Terms* — Aspect-Oriented Software Development, Design methodology, Distributed systems, Object oriented methods, Service Oriented Architectures

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# Value Based Argumentation using Formal Concepts

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*Abstract* — We consider the problem of argumentation over actions for the development of new agent programs. The goal is to improve the representation of argumentation over actions by using Galicia, a tool based on Formal Concept Analysis and Relational Concept Analysis. The main objective of the paper is to show our findings in the advantage provided by a clear visualization of the interaction between the agents. While we are using here a simple scenario the end goal is a more complex one in which agents need a clear picture in their decision making encounter.

*Index Terms* — Cooperative systems, Distributed computing, Intelligent systems, Interactive systems, Knowledge representation

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# Ontology Based Modeling of Cultural Heritage Systems

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*Abstract* — Any virtual environment (VE) built in a classical way is dedicated to a very specific domain. Its modification or even adaptation to another domain requires an expensive human intervention measured in time and money. This way, the product, that means the VE, returns at the first phases of the development process. Our proposal is based on the description of the domain knowledge in a standard format and the assisted creation (using these pieces of knowledge) of the VE. This permits the explanation within the virtual reality (VR) simulation of the semantic of the whole context and of each object. This knowledge may be then transferred to the public users. Moreover, we may capitalize the knowledge concerning the environment resources (both geometrical and semantic) and sharing them between different VEs.<sup>2</sup>

*Index Terms* — Virtual reality, artificial intelligence, information system

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# Some Aspects of Data Integration in Data Mining Systems

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*Abstract* — The aim of this paper is to present some aspects of data preparation in the Knowledge Discovery in Databases process. We have made some experiments regarding data migration from MS Access to Oracle, respectively to DB2 UDB, as a first step in data preparation for data mining algorithms. We have decided to implement a data mining system in order to improve the personalized therapy of speech disorder assisted by Terapers system. Due to the limitation of MS Access, the DBMS used for Terapers, we intend to use for this data mining system a database management system to provide data mining features incorporated. The reason of these experiments is to find the best solution for that.

*Index Terms* — Knowledge Discovery in Database, data mining, data integration, data migration

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# Formation of Microrelief on the Base of Multilevel Elevations Maps

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*Abstract* — There had been considered the issues on usage of perturbation functions for microrelief rendering. There had been suggested the methods for prescribing and rendering of microrelief on the base of multi level elevation map. There had been shown the advantages before the existent methods of microrelief rendering. In comparison with the known methods in the suggested methods, the time of calculations during the relief generation practically does not depend on elevation map resolution. In the suggested method of microrelief generation for the microrelief representation and levels of detail changing the same mechanism is used as for the usual texture.

*Index Terms* — microrelief, multilevel elevation maps, multilevel ray-tracing, perturbation function, rendering

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# The BRDF Models Based on the Cosine-quadratic Function

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*Abstract* — This paper describes several approaches to approximate bidirectional reflectance distribution function (BRDF) by cosine-quadratic functions. Since BRDF is the most computationally complicated part of calculating the color intensity according to the Phong illumination model it needs to be simplified. Herein, several approximations are provided. The advantages of them are numerous: easy hardware implementation, less relative error, than most widespread approximations have, fast to compute.

*Index Terms* — Approximation methods, computer graphics, Color graphics, Graphics, Rendering, BRDF

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# VRDN: A Software Environment for Visual Simulation of Rewriting Generalized Timed Differential Petri Nets Models

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*Abstract* — This paper presents the Rewriting generalized Differential Petri nets (RGDN) a class of Petri nets, that accept the negative-continuous place capacity, negative real values for discrete and continuous place marking and negative marked-dependent arc cardinalities. For the purpose of visual simulation and analysis of RGDN a Visual Rewriting Differential Petri Nets (VRDN) software environment has been elaborated and developed. It offers an intuitive graphical user interface for designing various elements of nets as well as their efficient simulation, thus making it usable for research and academic activities.

*Index Terms* — hybrid systems, modeling, Petri nets, rewriting, software tool, visual simulation

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# Information Technology Approach to Individual "Knapsack Problem" (Nanologistics)

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*Abstract* — The main aim of this article is shown new approach to the solving of the classical individual goods "knapsack problem" on the base of modern information technology. First of all in the frame of the modern logistics a new branch named nanologistics have been separated. It is oriented to investigation of an individual logistics behavior and design optimal solutions for his logistics goals. The individual logistics roles are presented und discussed. The basic ideas are introduced. A technique and a problem solving procedure for an individual goods basket forming are shown. The logistics cost less goods basket is formed with responsiveness to individual features and an allowance for risks and by fulfillment of some limitation.

*Index Terms* — integer programming, Internet, logistics, management information systems, optimization methods

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# Cryptoresistant Generator of Binary Key Sequences on the Basis of Cellular Automata

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*Abstract* — In this paper the cryptoresistant generator of pseudorandom binary consecution is developed and implemented on the basis of unidimensional cellular automata. The determined algorithm of regular bit selection, which can be easily reproduced on a receiving side, is offered. The statistical analysis of the obtained results is conducted by the package of NIST-STS.

*Index Terms* — binary sequences, cellular automata, initial state, pseudorandom number generator, idle cycles

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# ICT serves Business Training: Implementing Life-Long-Learning

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*Abstract* — Much of the economic activity and most of the employment in EU countries is provided by SMEs, Small and Medium Enterprises. The most vibrant sector that promises a good prospect for future growth is that of ICT and other Technologies. These companies employ a high proportion of University graduates many of them from science and engineering, subject areas in which new knowledge is constantly being generated. How are these workers to be kept up to date? Traditional training is giving way to Life-long-learning and for high tech companies whose workers have good ICT skills e-Learning can be effective and efficient, but planning and implementation must be carefully carried out to enable new knowledge to be harnessed to meet business needs. This paper sets out a tried and tested process in e-Learning planning and implementation for SMEs based on a holistic approach firmly rooting LLL at the core of strategic planning.

*Index Terms* — Business Planning, Education, Educational Technology, Learning Systems, Training

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More references are available on-line at [www.dasconference.ro](http://www.dasconference.ro).



# New Trend on OPC Middleware

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*Abstract* — A new trend on OPC Middleware is presented in this paper. In addition to general solutions of middleware (CORBA, Java RMI, DCOM), the attention focuses over OPC Foundation specifications, meaning: OPC Data Access, OPC Alarms & Events, OPC Historical Data Access, OPC XML-Data Access, OPC Unified Architecture and OPC Express Interface. OPC Unified Architecture (OPC UA) signifies a new standard of the OPC Foundation, providing interoperability in process automation and beyond.

Time specific to read OPC items on Windows and Linux platforms is also emphasized. At the end of this paper, strategies of migrating to OPC UA applications are introduced.

*Index Terms* — Middleware, Object Linking and Embedding for Process Control (OPC), OPC Data Access, OPC XML DA, OPC Unified Architecture

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# A Bee-inspired Approach for Selecting the Optimal Service Composition Solution

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*Abstract* — This paper presents a bee colony optimization method for selecting the optimal solution in semantic Web service composition. The bee-inspired selection method uses an enhanced planning graph model and a matrix of semantic links to incrementally search the optimal solution. We use a multi-criteria function which evaluates whether a solution is optimal or not in terms of its QoS attributes and the quality of the semantic match between the services involved in the solution. The selection method was validated by making experiments on a set of semantic Web services from the trip planning domain.

*Index Terms* — bee colony optimization, enhanced planning graph, ontology, semantic Web service, service composition

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# Modelling the Probability of Deadlocks in a Multithreading Process

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*Abstract* – This paper addresses some aspects on modeling a problem in continuous probability theory. We start describing a common problem in current computer science, the deadlock. This is followed by a mathematical abstraction of the problem. Three solution models are presented for it, two of them designed for multidimensional cases. These models are then tested in experiments and compared against the exact solutions.

*Index Terms* – Continuous Probability Theory, Geometry, Monte-Carlo Simulation, Parallelization, Threading

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# System for Real Time Detection of Hands and Pedestrians Movements

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*Abstract* — Interaction with virtual reality systems involves both navigation in virtual environments and virtual object manipulation. Hand gestures are used for direct interaction with virtual objects, while human body postures serves as navigation commands.

The proposed system is focused on the human detection task in a video stream. Once a target is detected the system continues, in the obtained region of interest, the analysis of the motion history, the object tracking, and determines the convexity of the hand image.

The developed method is able to detect and track multiple targets. The hand convexity analysis presented in the paper may be useful in other gestures recognition systems.

*Index Terms* — hand posture, computer vision, human computer interaction (HCI), pedestrian detection

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# The Application of Genetic Algorithm for Training "Without a Teacher"

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*Abstract* — The algorithm of determination of reference patterns for classification in the conditions of training «without a teacher» is described in this paper. The case is considered when patterns are set by  $n$  – measured vectors of numerical stochastic signs. For finding the coordinates of reference vectors it is offered to use Genetic Algorithm.

*Index Terms* — Recognition, Training, Self-training, Vector of Signs, Space of Signs, Optimal Estimations, Genetic Algorithm, Genetic Operations

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# HL7 Messaging Engine with Customizable Translation System

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*Abstract* — This paper introduces a new client-server messaging engine used to exchange clinical data between various medical software applications. Our portal uses the HL7 (Health Level Seven) messaging standard to provide translated clinical data to HL7 and non-HL7 client applications. We used HL7 because this standard is worldwide used to facilitate the communication between clinical applications.

*Index Terms* — Medical services, HL7, Client-server systems, Data communication, RFID

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# A Distributed RFID Based System for Patients' Identification and Monitoring

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*Abstract* — The goal of this paper is to present a distributed RFID (Radio Frequency Identification) based system for patients' identification and monitoring. The system we propose is intended to reduce medical mistakes, improve the patients' overall safety and enhance the quality of medical services in hospitals. By using the RFID technology, the patients can be easily identified and the risk of administrating wrong medication in case of an emergency will be highly reduced. Our system is also able to integrate and exchange information with other HL7 (Health Level Seven) based clinical applications already developed by other companies or organizations.

*Index Terms* — EHR (Electronic Health Record), EMR (Electronic Medical Record), HL7, RFID, Tag

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## INDEX OF AUTHORS

ABABII, Victor .....	67
ALBU, Mihai .....	38
ALEXA, Dimitrie .....	68
ALEXANDRU, Nicolae Dumitru .....	20, 46, 48
ARDELEAN, Simona .....	33
AROTĂRIȚEI, Dragos .....	84
ATĂNĂSOAE, Pavel .....	27
BĂLAN, Titus-Constantin .....	55
BALMUȘ, Ion .....	97
BAZAVAN, Radu .....	21
BIROU, Iulian T. ....	22, 37
BOGDAN, Ion .....	47
BOGDAN, Crenguta-Madalina .....	93
BOLDIȘOR, Cristian .....	32
BOLOHAN, Emanuela–Alina .....	94
BRKIC, Miodrag .....	71, 72
BUTA, Georgiana .....	78
BUTNICU, Dan .....	68
BUZATU, Nicoleta Roxana .....	52, 68
BUZATU, Oana Loredana .....	68
BUZDUGA, Vasile .....	26
CAZACU, Virgil .....	55
CERLINCĂ, Marius .....	106, 107
CERLINCĂ, Tudor .....	106, 107
CERNAT, Mihai .....	30
CHEIBAȘ, Victor .....	97
CHICIUDEAN, Dan .....	73
CHICULIȚĂ, Claudiu .....	80
CHIFU, Viorica Rozina .....	102
CHIUCHISAN, Iuliana .....	75
CIOBANU, Romeo-Cristian .....	29
CIOBANU, Iulia Brîndușa .....	74
CIURUȘ, Ioan Marcel .....	42
COCA, Eugen .....	78
COJOCARIU, Elena .....	52
COJOCARU, Ion .....	62, 63
COJUHARI, Irina .....	40
COMNAC, Vasile .....	32
CONDOR, Irina .....	102
CORDUNENU, Alexei .....	97
CORNOIU, Sorina .....	90
COSTACHE, Cosmin .....	57
COTAE, Paul .....	58
CRĂCIUN, Gina .....	104
CRAUS, Mitică .....	84
CRUCERU, Cristina .....	28
CSEREY, Szilard .....	55, 56
CURÉLY, Jacques .....	83
DAMNJANOVIĆ, Mirjana .....	81



DANUBIANU, Mirela .....	94
DARIE, Angela .....	47
DE MEY, Gilbert .....	69
DE STRYCKER, Lieven .....	45
DIETRICH, Felix .....	103
DIMIAN, Mihai .....	42, 79
DINSOREANU, Mihaela .....	102
DODIU, Eugen .....	34, 44
DOGAN, Viktor .....	70, 72
DUMITRESCU, Iulia .....	65
DUMITRIU, Lucia .....	66
ESTUBLIER, Jacky .....	91
FILOTE, Constantin .....	73
FLOROIAN, Dan .....	30
FODOR, Mihaly .....	102
FRANGU, Laurențiu .....	80
FRATAVCHAN, Valeriy .....	105
GAITAN, Cristina N. ....	34, 44
GAITAN, Vasile G. ....	34, 44, 101
GAITAN, Adrian M. ....	34, 101
GHENGHEA, Mihai .....	47
GHERASIM, Simona-Anda .....	101
GHERMAN, Ovidiu .....	54
GHIDUS, Gabriel .....	35
GOEMAERE, Jean-Pierre .....	45
GORON, Anca .....	92
GRAUR, Adrian .....	34, 42, 53, 75, 78, 79
GROZA, Adrian .....	88
GUTULEAC, Emilian .....	67, 97
GYSELINCK, Johan .....	25
HALL, Timothy .....	100
HAMBURG, Ileana .....	100
HOLBAN, Ștefan .....	86
HOPÎRTEAN, Mihai .....	33, 69
HORGA, Vasile .....	38
IONEL, Octavian .....	62, 63
IONESCU, Daniela .....	74
IONITA, Mihaela .....	65
IONITA, Anca Daniela .....	91
IORDACHE, Mihai .....	65, 66
IZVOREANU, Bartolomeu .....	39
JELIĆ, Miodrag .....	51
KRAPIVIN, V.F. ....	36
KRASNOVSKI, Denis .....	98
KUNTMAN, H. Hakan .....	9
LAZAR, Georgian Alexandru .....	52, 68
LEON, Florin .....	84
LETIA, Ioan Alfred .....	87, 88, 90, 92
LIVADARU, Leonard .....	35
LIVINȚ, Gheorghe .....	38
LOGOFĂTU, Doina .....	103
LUKIC, Milan .....	71
LUKIC, Svetlana R. ....	64
LYASHENKO, Yuri .....	96
MAHBUB, Shahriar .....	49
MAIER, Virgil .....	37

MALEA, Adriana-Georgiana .....	86
MANDACHE, Lucian .....	66
MANU, Octavian .....	79
MARIAN, Dan Alexandru .....	87
MARTINEAC, Corina .....	33, 69
MARTIS, Claudia .....	25
MĂZĂREL, Marius .....	80
MELIȚĂ, Nicolae .....	86
MELLETT, Sinead .....	100
MICEA, Mihai V. ....	73
MIHAI, Sorin .....	35
MILE-CIOBANU, Eugen .....	56
MILOSAVLJEVIC, Vladimir .....	70
MOLDOVEANU, Florin .....	24, 28, 30
MOTOASCA, Septimiu .....	77
MUKHIN, Vadym .....	85
NAUWELAERS, Bart .....	45
NEACA, Mitica Iustinian .....	60
NEACA, Andreea Maria .....	60
NEGURA, Valentin .....	67
NITU, C. ....	36
O'BRIEN, Emma .....	100
OICĂ, Gicu .....	27
OLESCHUK, Valentin .....	76
ONET, Oana .....	33
OSTAPOV, Sergey .....	98
PAVEL, Sorin .....	37
PAVLIDIS, Evgeni .....	103
PENTIUC, Ștefan Gheorghe .....	44, 54, 104
PETRUS, Vlad .....	25
PISICĂ, Ioana .....	43
PISLARU, Marius .....	29, 31, 41
POP, Adrian-Cornel .....	25
POP, Cristina Bianca .....	102
POPA, Adrian .....	50
POPA, Valentin .....	78, 101
POPESCU, Anca .....	61
POPOVICI, Dorin-Mircea .....	93
POSTOLACHE, Petru .....	43
POTORAC, Alin Dan .....	53, 75
PRODAN, Remus .....	106, 107
PRUDEAK, Roman .....	76
PUIU, Dan .....	24
QUERREC, Ronan .....	93
RĂȚOI, Marcel .....	38
ROBU, Dan Nicolae .....	57
ROMAHYUK, Alexander .....	96
ROMANIUK, Oksana V. ....	95
RUSU, C. G. ....	22
RUSU, Ionela .....	104
RYVKIN, Sergey .....	98
SALOMIE, Ioan .....	102
SANDU, Florin .....	55, 56, 57
SANDU, Venetia .....	82
SCHREINER, Cristina .....	41
SCUTARU, Gheorghe .....	77

SHARMIN, Nusrat .....	49
SIMION, Alecsandru .....	35
SIMION, Daniel .....	53
SIZOV, Alexandr .....	76
SLANKAMENAC, Miloš .....	51, 64
SOLDATOV, V.Yu. ....	36
SPINU, Leonard .....	19
SPIRIDONICĂ, Alexandru-Mihnea.....	29, 31, 41
STANCA, Aurel Cornel .....	82
STANCOVICI, Andrei .....	73
STĂNICĂ, Olivian .....	59
ȘTEFĂNESCU, Silviu .....	69
STEIMEL, A. ....	1
STICEA, Daniel .....	38
STOJANOVIĆ, Nikola .....	51
STRUNGARU, Rodica .....	21
SUCIU, Alexandru .....	26
SUDACEVSCHI, Viorica .....	67
SULIMAN, Caius .....	24, 28
SZEKELY, Iuliu .....	82
TEODOROVIC, Predrag .....	71
ȚIGĂNESCU-AMARIȚII, Radu .....	23, 94
ȚOPA, Iulian .....	32
ȚOPA, Vasile .....	69
TRANDABAT, Alexandru .....	41
TRIFINA, Lucian .....	52
ȚURCANU, Iurie .....	97
TURCU, Antoniu .....	37
TURCU, Cristina .....	106
TURCU, Cornel .....	107
UNGUREAN, Ioan .....	44, 54
URSULEANU, Mihai-Florentin .....	53
VAL', Lidiya .....	99
VAN NIEUWENHUYSE, Anneleen .....	45
VASILĂȚEANU, Andrei .....	62
VATAVU, Radu Daniel .....	104
VERMEȘAN, Claudiu .....	33
VESA, Tudor .....	33
VIERU, Razvan .....	52
VIZITIU, Gabriela .....	26
VOLOKYTA, Artem .....	85
VULTUR, Oana .....	54
VYATKIN, Sergei I. ....	95
WILFERT, Dennis .....	103
WYFFELS, Jeroen .....	45
YAROVYY, Andriy .....	89
ZHIKHAREVICH, Vladimir .....	99
ŽIVANOV, Milos .....	51, 64, 70, 71, 72, 81
ŽIVANOV, Ljiljana .....	81



**1985-2010**

**25 years**

**of**

**Electrical Engineering Higher Education in Suceava**

## TIMELINE HISTORY

- **1985**
  - *Power Engineering* was introduced to train engineers (6 years of studies and evening courses only)
- **1986**
  - evening courses in *Automation and Computers* were held for the first time (6 years of studies)
- **1990**
  - day courses on a 5-year basis were first introduced for both specializations;
  - *Automation* and *Electromechanics* specializations were established, Engineer degree, day courses (5 years) and evening courses (6 years);
  - *Electrotechnics Chair* was established, which represented the forerunner of the *Faculty of Electrical Engineering*;
  - the *Inventics Center* started its activity led by Prof. eng. Dorel CERNOMAZU, Ph.D.
- **1991**
  - *Faculty of Electrical Engineering* was established;
  - *Computers and Automation Chair* was established;
  - the Engineer Diploma was awarded to the first generation of graduates in *Power Engineering*
- **1992**
  - *Automation and Industrial Informatics* specialization was established, Engineer degree, day courses (5 years) and evening courses (6 years);
  - the Engineer Diploma was awarded to the first generation of graduates in *Automation and Computers*;
  - the first edition of the International Conference on Development and Application Systems (DAS) was organized (biennial scientific event, <http://www.dasconference.ro>);
- **1993**
  - *General Electrotechnics* specialization was established, Engineer degree, day courses (5 years);
  - *Computers* specialization was established, Engineer degree, day courses (5 years);
- **1994**
  - on 16 December 1994, the C building University building was inaugurated. It provides a surface of 3.500 m<sup>2</sup> and houses the *laboratories of the Faculty of Electrical Engineering*;
  - the first edition of the International Computers Contest for Students "Hard&Soft" (yearly scientific event, <http://www.hardandsoft.ro>) was held;
  - the first issue of our Faculty scientific journal: *The Annals of the "Stefan cel Mare" University, Electrical Section* ISSN 1222-4316 was published; it appeared biannually until 2001 (<http://www.eed.usv.ro/anale>) and was included in B category by CNCSIS;
- **1995**
  - the specializations *Power Engineering* and *Computers* were accredited under HG 568 / 16.08.1995;
  - the anniversary event "10 years of Electrical Higher Education in Suceava" was organized;
  - the first generation of graduates majored in *Electromechanics*;
- **1998**
  - inauguration on 21 May 1998 of a new faculty building (D building); it provides a surface of 3.500 m<sup>2</sup>, and houses the *Faculty of Electrical Engineering*, amphitheatres, laboratories and seminar rooms;
  - periodical evaluation and reconfirmation of the accreditation of *Power Engineering* specialization by HG 442 / 10.08.1998;
  - the first generation of graduates majored in *General Electrotechnics*;

- *Computer Use* postgraduate training program (4 months) was set up;
- **1999**
  - the specializations *General Electrotechnics*, *Power Engineering* and *Computers* received EFNAE accreditation (European Federation of National Associations of Engineers);
  - *Intelligent Systems for Process Control* Master program, 1 year, was launched;
  - the first Organization of Electrical Engineering Students (OSăFIE) was established;
- **2000**
  - the Ph.D. programs in *Electrical Engineering* (Ph.D. supervisor: Prof. eng. Dorel CERNOMAZU, Ph.D.) and *Electronic Engineering and Telecommunications* (Ph.D. supervisor: Prof. eng. Adrian GRAUR, Ph.D.) were established;
  - *Informatics* Master program, 2 years, was established;
  - *Economic Engineering in Electrical and Energetic Field* specialization was set up, Engineer degree, day courses, (5 years);
- **2001**
  - the first issue of the new scientific journal of our faculty: *Advances in Electrical and Computer Engineering*, ISSN: 1582-7445, e-ISSN: 1844-7600, doi: 10.4316/aece, appeared and was later classified B, B+ and A by CNCSIS, being co-edited by Romanian Academy of Technical Sciences;
  - the Ph.D. program in *Computer Science* (Ph.D. supervisor: Prof. eng. Ștefan-Gheorghe PENTIUC, Ph.D.) domain was established;
  - the postgraduate training courses (4 months) *WEB Design* and *Internet Applications Programming* were launched;
- **2002**
  - *Electronics* specialization was set up, Engineer degree, day courses, (5 years);
- **2003**
  - *Computers II Chair* was established;
  - *General Electrotechnics* specialization was accredited;
  - *PC Use and Birotics Programs*, *Electroenergetic Balance Sheets* and *Energy Management* postgraduate training courses (4 months) were launched;
  - the first edition of the National Scientific Seminar *Distributed Systems* was held (yearly scientific event, <http://www.eed.usv.ro/SistemeDistribuite>);
- **2004**
  - the National Council for Research in Higher Education accredited the three scientific research centers in our faculty: *Research Center in Electrical Machines, Apparatus and Drives – EMAD*, *Research Center for Process Control Systems Research - SISCON*, *Research Center in Computer Science – CCSC*;
  - *Intelligent Systems for Process Control* (one year courses), *Computer Engineering and Process Control* (2 year courses), *Computer-Aided Visual Art* (2 years), *Visual Arts, Design and Advertising Image* (2 years) Master programs were set up;
  - periodic evaluation and re-accreditation of *Computers* and *Power Engineering* specializations;
  - *Training Courses in PC Utilization and Office Programs* and *Project and Human Resources Management* postgraduate training courses (4 months) were set up;
- **2005**
  - *The Center for Formation and Training in Communication and Information Technologies* was established (PROCES);
  - *Computer Science and Engineering*, *Informatics Management in Industry and Administration*, *Advanced Techniques in Electrical Machines and Drives* and *Modern Systems for Energetic Process Control* Master programs (2 year courses) were set up;
  - the Engineer degree program length decreases from 5 to 4 years (according to the Bologna Statement), and the names of the following specializations change as follows: *Power Engineering* becomes *Power Management*, *General Electrotechnics* becomes *Electrical Systems* and *Electronics* becomes *Applied Electronics*;
  - the first edition of the biennial International Symposium on Electrical Engineering and Power

Conversion (ELS) - (<http://www.eed.usv.ro/html/els.html>);

- **2006**
  - *CAD Applications Development in Electric and Energetic Fields* postgraduate training courses (4 months) were set up;
  - the first edition of the yearly *StudACE* Student Workshop was organized (<http://www.eed.usv.ro/StudACE>);
  - The Student Association of the Faculty of Electrical Engineering and Computer Science (FI@ESC) was set up;
- **2007**
  - the scientific journal of the faculty, *Advances in Electrical and Computer Engineering*, is indexed and abstracted in Science Citation Index Expanded by ISI Thomson Reuters;
  - our Faculty awarded the Honorary Teaching Degree to *Jean Michel DUTHILLEUL*, Polytech'Lille, Universite de Science et Technologies de Lille, France;
  - the MEC Order 477 / 05.03.2007 certified the *Informatics* postgraduate professional conversion program (2 years);
  - the first edition of the yearly Scientific Communication Session for Students - ELSTUD (<http://www.eed.usv.ro>);
- **2008**
  - on 14-th of June the *Laboratory of Electromagnetic Compatibility* was set up ([www.emclab.ro](http://www.emclab.ro));
  - our Faculty awarded the Honorary Teaching Degree to *John MILNER* and *Timothy HALL*;
  - the BSc programs (4 years) *Economic Engineering in Electric, Electronic and Energetic Field* and *Automation and Applied Informatics* were accredited;
  - periodic evaluation and re-accreditation of *Electrical Systems* specialization;
  - the Club for Robotics and Open Source of the students from Faculty of Electrical Engineering and Computer Science (CROS) was setup;
- **2009**
  - *High Performance Computing Laboratory*, equipped with the most powerful parallel computing system in the national academic environment, was set up;
  - Two test laboratories, *Test Laboratory for Product Quality Certification – CERTeLAB* and *RFID Test Laboratory - SRD-RFID*, were accredited by RENAR under EN 17025:2005 standard (<http://www.emclab.ro> / <http://www.emclab.eu>);
  - the followings were confirmed as Ph.D. supervisors: Prof. dr. eng. Valentin POPA, (*Electronic Engineering and Telecommunications*), Prof. dr. eng. Vasile GĂITAN, and Prof. dr. eng. Cornel Octavian TURCU, (*Computers and Information Technologies*);
  - *Computer and Communication Networks, Computer and Communication Networks, Software Engineering, Computer Networks, Advanced Embedded Systems* Master programs (2 years) were set up;
  - all Master programs of our Faculty were internally accredited, and later listed in OMECI no. 5356 from 29/09/2009;
  - *Electrical Machines and Drives* postgraduate training course (4 months) was licensed;
  - our Faculty awarded the DOCTOR HONORIS CAUSA honorific degree to: *Prof. dr. eng. Mircea PETRESCU*, *Prof. dr. eng. Radu MUNTEANU*, *Prof. dr. eng. Costică NITU*, *Prof. dr. eng. Petru LEONTE*, *Ph.D.*, *Prof. dr. eng. Alecsandru SIMION*;
  - the USV Gold Medal was awarded to *Eng. Ovidiu MUSTAȚĂ, Ph.D.*
- **2010**
  - periodic evaluation and re-accreditation of *Computers and Power Engineering* specialization;
  - *Applied Electronics* BSc program was accredited;
  - our Faculty awarded training certificates to *Power Engineering* teachers as recognition of their professional competences and skills, at different levels;



## ACADEMIC STAFF

All along these years of electrical engineering higher education in Suceava, the followings held the position of:

### A. TENURED ACADEMIC STAFF

No	First name / Last name	Tenure year	No	First name / Last name	Tenure year
1.	Adrian GRAUR	1977	38.	Oana Magdalena COȘMAN	1998
2.	Sonia GUTT	1978	39.	Iuliana DAȘU	1998
3.	Leon MANDICI	1978	40.	Cristian Andy TĂNASE	1998
4.	Cătălin ȚIGĂERU	1988	41.	Liviu TITU	1998
5.	Narcisa AIROAEI	1990	42.	Elena Crenguța BOBRIC	1999
6.	Lăcrămioara BULAT	1990	43.	Gabriela RAȚĂ	1999
7.	Dorel CERNOMAZU	1990	44.	Adina Luminița BĂRÎLĂ	2000
8.	Paul CHIRILĂ	1990	45.	Marius CERLINCĂ	2000
9.	Ioan COJOCARIU	1990	46.	Alexandru LARIONESCU	2000
10.	Ștefan-Gheorghe PENTIUC	1990	47.	Constantin UNGUREANU	2000
11.	Valentin POPA	1990	48.	Cărlin CIUFUDEAN	2001
12.	Dan Alin POTORAC	1990	49.	Iulian CORDUNEANU	2001
13.	Teodor Dănuț STRUGARIU	1990	50.	Sorin POHOAȚĂ	2001
14.	Vasile Gheoghiță GĂITAN	1991	51.	Bianca Renata SATCO	2001
15.	Alexandru MARCU	1991	52.	Cristina BABIUC	2002
16.	Tudor MOROȘAN	1991	53.	Marinică BOSÎNCEANU	2002
17.	Daniela MINESCU	1991	54.	Tudor CERLINCĂ	2002
18.	Georgel PAICU	1991	55.	Eugen COCA	2002
19.	Mircea Lucian RUSU	1991	56.	Adrian Dumitru CREȚU	2002
20.	Ioan MĂCINCĂ	1991	57.	Mirela DANUBIANU	2002
21.	Constantin FILOTE	1992	58.	Daniel Toader ONOFREI	2002
22.	Cezar Dumitru POPA	1992	59.	Dorin PALANCIUC	2002
23.	Ioan TOMA	1992	60.	Iuliana CHIUCHIUȘAN	2002
24.	Corneliu Octavian TURCU	1992	61.	Adrian PENIȘOARĂ	2002
25.	Cristina Elena TURCU	1992	62.	Ana-Maria COZGAREA	2003
26.	Niculai BARBĂ	1993	63.	Felicia GÎZĂ	2003
27.	George MAHALU	1993	64.	Raluca IUREA	2003
28.	Radu Dumitru PENTIUC	1993	65.	Alexandra Ligia ONOFREI	2003
29.	Cristinel PETRIȘOR	1993	66.	Ovidiu SCHIPOR	2004
30.	Radu FECHET	1994	67.	Mihai DIMIAN	2007
31.	Laurențiu Dan MILICI	1994	68.	Ciprian AFANASOV	2007

32.	Remus Cătălin PRODAN	1995	69.	Alexandru GOLOCA	2007
33.	Mihai RAȚĂ	1995	70.	Radu SAGHIN	2008
34.	Cătălin Marian SÎICU	1995	71.	Cristina HURJUI	2008
35.	Andra IGNAT	1996	72.	Elena OLARIU	2008
36.	Mariana Rodica MILICI	1996	73.	Radu VATAVU	2008
37.	Catalin TIGAERU	1996			

## B. HONORARY PROFESSORS

- Jean Michel DUTHILLEUL – *Polytech’Lille, Universite de Science et Technologies de Lille, France*
- John MILNER - *City London University, Great Britain*
- Timothy HALL – *University of Limerick, Ireland*

## C. SUPPORT STAFF

No.	First name / Last name	Hiring year	No.	First name / Last name	Hiring year
1.	Livia PRODAN	1978	17.	Aurel CHIRAP	1990
2.	Doina VICOL (CIUHAN)	1978	18.	Mariana LELESCU	1992
3.	Doina TANĂSICIUC	1978	19.	Luca CÂMPAN	1992
4.	Trandafira CURIC	1979	20.	Carmen SOCIU	1993
5.	Valeria PUPĂZĂ	1980	21.	Remus PRODAN	1995
6.	Dorin GRĂDINARU	1980	22.	Valentina PRODAN	1996
7.	Gheorghe SIMIONIUC	1981	23.	Daniel GEORGESCU	1997
8.	Liliana GÎLIȚĂ	1981	24.	Ioan CHIFAN	1997
9.	Brighita PILAT	1981	25.	Adrian Dumitru CREȚU	1997
10.	Ilie NIȚAN	1985	26.	Mircea NAROVICI	1998
11.	Doina CANURĂ	1986	27.	Marius BUTA	1999
12.	Gheorghe SIMERIA	1986	28.	Mihaela BUJANOVACHI	2002
13.	Viorel CUCU	1990	29.	Laura DOSPINESCU	2002
14.	Ioan GAVRILIUC	1990	30.	Lucian SPETCU	2008
15.	Sorin POHOAȚĂ	1990	31.	Iulian CHIUCHIȘAN	2008
16.	Elena CURELARU	1990	32.	Gheorghe PENTIUC	2010

## INVENTIONS CENTER

The Inventions Center started its activity in 1990, led by Professor Dorel CERNOMAZU. The continuous development in this domain is reflected by scientific papers elaborated and published in prestigious journals, through numerous patents obtained in the last years, through research projects and even through doctoral theses, dissertations and diploma projects.

Research directions of Invention Center are:

- Solar engines;
- Sensors and transducers;
- Transformers;
- Electrostatic motors;
- Linear Motors;
- Piezoelectric motors;
- Shielded pole motors;
- Vibromotors;
- Electromechanical actuators and the liquid pumps;
- Electromechanical actuators with paraffin;
- Improving the safety of high voltage equipment.

The research results were evidenced through international and national exhibition awards.

1. CERNOMAZU, M.; GRAUR, A.; MANDICI, L. *Excellence Diploma*. The 8th edition International Salon of Research, Innovation and Invention PRO-INVENT Cluj-Napoca, 2010.
2. CERNOMAZU, M.; MANDICI, L.; UNGUREANU, C. *Gold Medal*. The 8th edition International Salon of Research, Innovation and Invention PRO-INVENT Cluj-Napoca, 2010.
3. Georgescu, D.; Jeder, M.; Olariu, E.D.; UNGUREANU, C. *Gold Medal*. The 8th edition International Salon of Research, Innovation and Invention PRO-INVENT Cluj-Napoca, 2010.
4. GRAUR, A. *Leonardo da Vinci Scientific Order for Commanders*. European Exhibition of Creativity and Innovation EUROINVENT 2010, Iași, Romania
5. SOREA, N.; MANDICI, L.; CERNOMAZU, D. *Gold Medal*. European Exhibition of Creativity and Innovation EUROINVENT 2010, Iași, Romania
6. CERNOMAZU, D.; GRAUR, A.; MANDICI, L.; SIMION, Al. *Silver Medal*. European Exhibition of Creativity and Innovation EUROINVENT 2010, Iași, Romania
7. CERNOMAZU, D.; GRAUR, A.; MANDICI, L. *Silver Medal*. European Exhibition of Creativity and Innovation EUROINVENT 2010, Iași, Romania
8. CERNOMAZU, D.; MANDICI, L.; PRISACARIU, I. *Bronze Medal*. European Exhibition of Creativity and Innovation EUROINVENT 2010, Iași, Romania
9. CERNOMAZU, D. *"Inventive Merit" Medal*. Inventics Institute of Iași, International Salon of Research, Innovation and Invention, Cluj-Napoca, 2009.
10. CERNOMAZU, D.; UNGUREANU, C.; MANDICI, L. **Excellence Diploma** for *Low Speed Electric Motor* Romanian Inventors Society, The 7th edition International Salon of Research, Innovation and Invention PRO-INVENT, Cluj-Napoca, 2009.

11. CERNOMAZU, D.; MANDICI, L.; SIMION, Al. et. al. *Excellence Diploma and Gold Medal*. The 7th edition International Salon of Research, Innovation and Invention PRO-INVENT, Cluj-Napoca, 2009.
12. GEORGESCU, D.; JEDER, M.; OLARIU, E.D. *Excellence Diploma and Gold Medal* The 7th edition International Salon of Research, Innovation and Invention PRO-INVENT, Cluj-Napoca, 2009.
13. GRAUR, A.; CERNOMAZU, D. *Gold Medal. – Single phase Induction Motor*. Romanian Inventor Forum, The 7th edition International Salon of Research, Innovation and Invention PRO-INVENT, Cluj-Napoca, 2009.
14. GRAUR, A. *Excellence Diploma for Promotion of Inventics and the Field Management in Higher Education*. Romanian Inventor Forum, The 7th edition International Salon of Research, Innovation and Invention PRO-INVENT, Cluj-Napoca, 2009.
15. CERNOMAZU, D.; MANDICI, L.; UNGUREANU, C. *Excellence Diploma. Low Speed Electric Motor*. Technical University of Moldova, The 7th edition International Salon of Research, Innovation and Invention PRO-INVENT, Cluj-Napoca, 2009.
16. CERNOMAZU, D.; MANDICI, L.; OLARIU, E.D. *Diploma and Bronze Medal EUREKA 2009 Energetics Section. Single phase Induction Motor with multiple rotors* Le salon International de l’Innovation, de la Recherche et des Nouvelles Technologies - 58ème édition: BRUSSELS INNOVA 2009” - BELGIA
17. Cernomazu, D.; Ungureanu, C.; Leonte, P.; Simion, Al. *Gold Medal. – Solar Micromotor*. International Specialized Exhibition of Inventions, New Equipment, Technologies and Materials INFOINVENT 2009, Chişinău, Republic of Moldova.
18. Cernomazu, D.; Graur, A.; Mandici, L. *Silver Medal. – Limited Movement Electric Motor*. International Specialized Exhibition of Inventions, New Equipment, Technologies and Materials INFOINVENT 2009, Chişinău, Republic of Moldova.
19. CERNOMAZU, D.; MANDICI, L.; OLARIU, E.D. *Silver Medal. - International Specialized Exhibition of Inventions, New Equipment, Technologies and Materials INFOINVENT 2009, Chişinău, Republic of Moldova*.
20. Cernomazu, D.; Ungureanu, C.; Gavriliu, M. et. al. *Solar Micromotor. – Silver Medal*. International Specialized Exhibition of Inventions, New Equipment, Technologies and Materials INFOINVENT 2009, Chişinău, Republic of Moldova.
21. Georgescu, D.; Jeder, M.; Olariu, E.D. *Mobile Coil Electric Motor– Silver Medal*. International Specialized Exhibition of Inventions, New Equipment, Technologies and Materials INFOINVENT 2009, Chişinău, Republic of Moldova.
22. Mandici, L.; Cantemir, L.; Pentiu, R.; Cernomazu, D. *Single phase Linear Induction Motor Motor liniar asincron – Bronze Medal*. International Specialized Exhibition of Inventions, New Equipment, Technologies and Materials INFOINVENT 2009, Chişinău, Republic of Moldova.
23. JEDER, M.; OLARIU, E.D. - *Bronze Medal*. International Specialized Exhibition of Inventions, New Equipment, Technologies and Materials INFOINVENT 2009, Chişinău, Republic of Moldova.
24. CERNOMAZU, D.; MANDICI, L.; UNGUREANU, C. *Low Speed Electric Motor. Silver Medal*. The International Exhibition of Inventions, New Techniques and Products - Geneva, 4 April 2008
25. CERNOMAZU, D.; MANDICI, L.; UNGUREANU, C. *Low Speed Electric Motor. Silver Medal*. Romanian Inventor Forum, World exhibition on innovation research and new technologies -EUREKA, Bruxelles, 15 November 2008
26. CERNOMAZU, D.; MANDICI, L. *Low Speed Electric Motor Silver Medal* World exhibition on innovation research and new technologies -EUREKA, Bruxelles, 15 November 2008

27. CERNOMAZU, D.; MANDICI, L.; UNGUREANU, C. *Low Speed Electric Motor* **Bronze Medal**. Organizers of International Exhibition of Novelties, New Ideas, Products and Technologies ARCA, Zagreb, Croatia, 19 September 2008.
28. CERNOMAZU, D.; MANDICI, L. *Low Speed Electric Motor* **Silver Medal**. Organizers of International Exhibition of Novelties, New Ideas, Products and Technologies ARCA, Zagreb, Croatia, 19 September 2008.
29. CERNOMAZU, D.; MANDICI, L.; UNGUREANU, C. *Low Speed Electric Motor* **Bronze Medal**. Awarded by ANCS at the International Exhibition of Novelties, New Ideas, Products and Technologies ARCA, Zagreb, Croatia, 19 September 2008.
30. CERNOMAZU, D.; MANDICI, L. *Low Speed Electric Motor* **Silver Medal**. Awarded by ANCS at the International Exhibition of Novelties, New Ideas, Products and Technologies ARCA, Zagreb, Croatia, 19 September 2008.
31. CERNOMAZU, D.; MANDICI, L.; UNGUREANU, C. **Excellence Diploma**. Ministry of Education and Youth, Technical University of Republic of Moldova, International Exhibition of Inventions, Research and Technology Transfer INVENTICA 2008, Iași.
32. CERNOMAZU, D.; MANDICI, L. **Bronze Medal**. The International Exhibition of Inventions, New Techniques and Products -Geneva, 4 April, 2008
33. CERNOMAZU, D. *Various Patents*. **Excellence Diploma and Gold Medal**. National Salon of Research, Innovation and Invention PRO-INVENT, 6<sup>th</sup> edition, 2008, Cluj-Napoca
34. CERNOMAZU, D.; BARBĂ, N.; HUȚANU, D.; MANDICI, L.; SIMION, AL.; BOBRIC, E.C. *Induction Motor, Electrostatic Motor, Electrostatic Micromotor*, **Excellence Diploma Iași 600 and Gold Medal**. International Exhibition of Inventions, Research and Technology Transfer INVENTICA 2008, 14-24 May 2008, Iași.
35. SAVU, E. *Various Patents*. **Excellence Diploma and Silver Medal**. National Salon of Research, Innovation and Invention PRO-INVENT, 6<sup>th</sup> edition, 2008, Cluj-Napoca
36. HARIP,C.; MELINCEANU, A.; COJOCARU, C. et.al. *Various Patents*. **Excellence Diploma and Bronze Medal**. National Salon of Research, Innovation and Invention PRO-INVENT, 6<sup>th</sup> edition, 2008, Cluj-Napoca
37. NEGRU, B.; MINESCU, D. **Excellence Diploma and Silver Medal**. National Salon of Research, Innovation and Invention PRO-INVENT, 6<sup>th</sup> edition, 2008, Cluj-Napoca
38. CERNOMAZU, D. **GOGU CONSTANTINESCU COMANDOR Order**, Romanian Inventors Society, National Salon of Research, Innovation and Invention PRO-INVENT, 5<sup>th</sup> edition, 2007, Cluj-Napoca.
39. CERNOMAZU, D.; GEORGESCU, D.; JEDER, M.; OLARIU, E.D. *Mobile Coil Electric*. **Gold Medal and Excellence Diploma** - National Salon of Research, Innovation and Invention PRO-INVENT, 5<sup>th</sup> edition, 2007, Cluj-Napoca.
40. CERNOMAZU, D.; MANDICI, L.; UNGUREANU, C. SIMION, AL. *Solar Motor*. **Silver Medal**. World Exhibition on Innovation Research and New Technologies “INNOVA” - EUREKA, Brussels, 24 November, 2007
41. CERNOMAZU, D. **Excellence Diploma** - „Leonardo da Vinci” **Technical-Scientific Order**, Romanian Inventors Forum, 3 March, Cluj-Napoca, 2006
42. CERNOMAZU, D. *Solar Engine* **Gold Medal and Excellence Diploma** - National Salon of Research, Innovation and Invention PRO-INVENT, 4<sup>th</sup> edition, 2006, Cluj-Napoca
43. CERNOMAZU, D. UNGUREANU, C. **Excellence Diploma**, Romanian Inventors Forum, Cluj-Napoca, 3 March 2006

44. CERNOMAZU, D.; MANDICI, L. - **Silver Medal**. World exhibition on innovation research and new technologies “INNOVA” - EUREKA, Brussels, 2006
45. CERNOMAZU, D. *Single phase Induction Motor*. **Gold Medal**. World exhibition on innovation research and new technologies “INNOVA” - EUREKA, Brussels, 19 November 2005
46. CERNOMAZU, D.; MANDICI, L. *Solar Engine*. **Silver Medal**. The International Exhibition of Inventions, New Techniques and Products -Geneva, 8 April 2005

## EMAD - RESEARCH CENTER IN ELECTRICAL MACHINES, APPARATUS AND DRIVES

Unconventional Actuators, Micromachines and Micropower Drives laboratory it's a part of the structure of Research Center in Electrical Machines, Apparatus and Drives recognized in 2004 by National Council of Scientific Research from superior education of Research and Education Minister.

The Unconventional Actuators, Micromachines and Microdrives laboratory has been founded in 1996, when the first solar electric engines were achieved under the guidance of Prof. Dorel CERNOMAZU and Prof. Leon MANDICI.



One year later, the first solar electric engines based on thermo-mechanic conversion were designed. The novelty and the originality of those achievements are confirmed through some patents released by State Office for Inventions and Marks.

The laboratory activity has increased amazingly in 2000, when the doctoral school in the unconventional actuators, micromachines and microdrives was created. Numerous scientific papers and patents in the field were conceived as a result of the young PhD students' research work: Constantin UNGUREANU, Elena OLARIU, Mihaela JEDER, Nicolae Sorea, Niculina Crețu. The acquired results were rewarded by many medals at national and international inventions centers organized in Iași, Cluj-Napoca, București, Chisinău, Geneva and Bruxelles.

The research directions which entailed the founding of Unconventional Actuators, Micromachines and Microdrives laboratory relies on the reconsideration of some categories of classic forces developed in magnetic field and electric field or another category of forces: forces based on solid structure deformation under the action of the electric field (piezoelectricity etc.) or under the action of the magnetic field; forces based on solid structure deformation under the action of the heat (thermo-bimetal; memory alloy etc.) and which brought in some prototypes in solar energetics (solar bimetallic engine, solar nitinol engine, solar pneumatic engine etc.); forces based on chemical reactions leading to the achievement of the electrochemical pumps; forces based on hydraulic effects uses (diaphragm actuators; piston actuators etc.). Non-conventional energy supply developments, micro wind turbine dimensioning and power system testing equipment represents new research directions.

## **SiSCON - SYSTEMS AND PROCESSES CONTROL RESEARCH CENTER**

SiSCON Research Center was created in 2004 by a group of university professors and researchers from the Computer, Automations and Electronics Department - Electrical Engineering and Computer Science Faculty, Stefan cel Mare University of Suceava, Romania. Our research center was authorized by the CNCSIS - The National University Research Council, which is the main Romanian government funding organization for university and postgraduate research programs.



Our main research areas include, without being exclusive, the following domains:

- Remote location and identification (RFID);
- Electromagnetic compatibility (EMC);
- Processes control and automations;
- Wired and wireless data transmissions;
- Digital signals processing;
- Power line carrier communications;
- Embedded processing systems;
- Network time synchronization and applications;

The Radio Identification devices and Short Range Devices is a component of the research center. The interests of this laboratory are teaching and research in the field of Radio Identification devices and Short Range Devices. The main objectives are represented by the insurance of a specific and particular environment for research activities, training of the newest generations of engineers and the guarantee of a permanent development of the perspectives regarding both research and didactic activity. The laboratory provided a favorable environment for developing the research activities, reflecting at the same time its real potential of performance and research. The Radio Identification (RFID) devices and Short Range Devices (SRD) laboratory is furnished with the latest technology to support research, a variety of testing / measuring SRD and RFID equipments is available in laboratory. The two main components involved in a RFID system are the transponder (tags) and the RFID reader.

The Electromagnetic Compatibility Laboratory - EMCLab, part of SiSCON Research Center, is located in Stefan cel Mare University of Suceava campus, in a modern new building. The laboratory is accredited by RENAR Bucharest, in conformity with SR EN ISO/CEI 17025:2005 international standard, for electromagnetic compatibility tests on information technology equipments, electrical and electronic equipments used in residential, commercial and industrial areas, 2.4 GHz broadband transmission equipments, communication networks equipments, Bluetooth devices, Short Range Devices and Radio Frequency Identification (RFID) equipments (the complete list of equipments may be found on the web-site). The laboratory started as a CEEX 2006 research project, the implementation team being formed by specialized personnel, well trained and with a lot of experience in the accredited field. The laboratory is involved in research projects related to test methods improvements, impact of electromagnetic radiation on humans and other live organisms, and biological effects of EMF. We are opened for collaboration in the EMC field with production partners, universities and research institutes for research projects partnerships.

<http://www.sisconresearch.ro>



## CCSC - COMPUTER SCIENCE RESEARCH CENTER

The research Center was recognized in 2003 by CNCSIS. Its main activities focus on the domain of Computer Science and Engineering and Information Technologies.

The Center maintains strong cooperation relationships with Laboratoire d'Informatique Fondamentale de Lille (U.S.T. Lille), National Center for Information Technologies (Politehnica University of Bucharest), Vinnitsa State Technical University from Ukraine, KAHO Gent, Belgium.



The major research fields are:

- Pattern Recognition,
- Software Engineering.
- Artificial Intelligence,
- Human Computer Interaction
- Distributed Intelligent Systems, Microprocessor Systems,
- Real Time Operating Systems,
- Computers Networks,
- Computers Architecture,
- Advanced Systems for Process Control.

The members of the Center provide great expertise in software design, embedded system development, process control integrated systems.

Computers Ph.D. students and Master students in Computer Science and Engineering, Software Engineering, Computer Networks, Advanced and Embedded Systems, Informatics programs actively involve in the all Research Center activities.