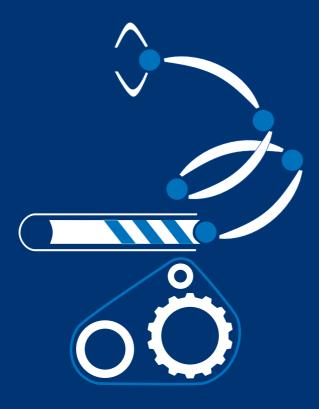


## JNI ECH 2016 GABROVO

## **INTERNATIONAL SCIENTIFIC CONFERENCE**



**PROCEEDINGS** 

VOLUME |

## TECHNICAL UNIVERSITY OF GABROVO



## INTERNATIONAL SCIENTIFIC CONFERENCE



# PROCEEDINGS VOLUME II

18 - 19 NOVEMBER 2016 GABROVO The Conference is organized with the financial support of:

AMK "DRIVE AND CONTROLS" GMBH
DSK BANK JSC
EXTRAPACK LTD.
IDEAL STANDARD - VIDIMA JSC
PODEMKRANE JSC
GWG GEWINDEWERKZEUGE GABROVO GMBH
STEMO LTD.
HAMBERGER BULGARIA GMBH
CERATIZIT BULGARIA JSC

The papers have been reviewed

© TECHNICAL UNIVERSITY OF GABROVO, 2016 © UNIVERSITY PUBLISHING HOUSE "V. APRILOV" – GABROVO, 2016

ISSN 1313-230X

## ТЕХНИЧЕСКИ УНИВЕРСИТЕТ - ГАБРОВО





## МЕЖДУНАРОДНА НАУЧНА КОНФЕРЕНЦИЯ



# СБОРНИК ДОКЛАДИ том п

18 – 19 НОЕМВРИ 2016 ГАБРОВО Конференцията се провежда с финансовата подкрепа на:

"АМК ЗАДВИЖВАЩА И УПРАВЛЯВАЩА ТЕХНИКА" ЕООД "БАНКА ДСК" ЕАД "ЕКСТРАПАК" ООД "ИДЕАЛ СТАНДАРТ – ВИДИМА" АД "ПОДЕМ-КРАН" АД "РЕЗБОНАРЕЗНИ ИНСТРУМЕНТИ ГАБРОВО" ЕООД "СТЕМО" ООД "ХАМБЕРГЕР БЪЛГАРИЯ" ЕООД "ЦЕРАТИЦИТ БЪЛГАРИЯ" АД

Докладите са рецензирани

## ТЕХНИЧЕСКИ УНИВЕРСИТЕТ – ГАБРОВО МЕЖДУНАРОДНА НАУЧНА КОНФЕРЕНЦИЯ УНИТЕХ'16

## СБОРНИК ДОКЛАДИ ТОМ II

Формат: 70/100/16 Печатни коли: 27.87

Печат: Университетско издателство "Васил Априлов" – Габрово

ISSN 1313-230X

## **VOLUME II**

## COMMUNICATION ENGINEERING AND TECHNOLOGIES

ANALYSIS OF POSSIBILITIES TO INCREASE	-7
TRAFFIC CAPACITY IN GSM SYSTEMS	57
Verica Marinković – Nedelicki	,
Institute for Telecommunications and Electronics, IRITEL a.d. BELGRADE, Serbia	
CALCULATING LOSS PROBABILITY IN MOBILE SYSTEMS	
WITH DTX IMPLEMENTATION	60
Aleksandar Lebl, Dragan Mitić, Vladimir Matić, Mihailo Stanić, Mladen Mileusnić, Žarko Markov	
Institute for Telecommunications and Electronics, IRITEL a.d. BELGRADE, Serbia	
PERFORMANCE COMPARISON OF MPSK, MFSK AND M-QAM MODULATION TECHNIQUES IN FADING CHANNELS USING DIFFERENT DIVERSITY	64
Dragan Mitić¹, Aleksandar Lebl¹, Djurdje Perišić², Željko Gavrić²  ¹ Institute for Telecommunications and Electronics, IRITEL a.d. BELGRADE, Serbia  ² Faculty for information technology-SPU, BIH	
SECURITY IN WIRELESS SENSOR NETWORKS	70
Teodora T. Stoyanova, Aleksander P. Milev	
Konstantin Preslavski University of Shumen, Bulgaria	
INFLUENCE OF CODER TYPE ON THE CHARACTERISTICS OF SIGNAL ECHO IN PACKET VOICE CONNECTIONS	75
Dragan Mitić <sup>1</sup> , Aleksandar Lebl <sup>1</sup> , Miroslav Popović <sup>2</sup> ,	13
Mladen Mileusnić <sup>1</sup> , Žarko Markov <sup>1</sup>	
<sup>1</sup> Institute for Telecommunications and Electronics, IRITEL a.d. BELGRADE, Serbia <sup>2</sup> Faculty of Technical Sciences, University of Novi Sad, Serbia	
IMPACT OF SOCIAL MEDIA	01
Selena Kutić, Zvezdan Stojanović	. 01
Serbia	
DEVELOPING A SYSTEM FOR IMPROVING QUALITY	
OF SERVICE IN OVERLAY NETWORK	86
Miroslav Slavov	
Technical University of Gabrovo, Bulgaria	
IMPLEMENTATION OF THE CONCEPT OF COMPUTER VISION	92
Konstantin Preslavski University of Shumen, Bulgaria	
RESEARCH OF RADIO FREQUENCY MODELS IN URBAN AREAS Nikolay Tashkov, Rosen Tsvetkov	97
Technical University of Gabrovo, Bulgaria	

RF PARALLEL-CIRCUIT CLASS E POWER AMPLIFAER 102 Iliya Nedelchev, Stanimir Sadinov, Miroslav Tomov Technical University of Gabrovo, Bulgaria
A SOLUTION FOR TRACING CONFIGURATION CHANGES IN USER ACTIVITY LOG IN AN OPTICAL NETWORK 108 Marko Radivojević, PetarKnežević, Mihailo Stanić
IRITEL a.d. BELGRADE, Serbia
AN APPROACH TO CORBA TECHNOLOGY USAGE IN NETWORK MANAGEMENT INTEGRATION
STUDY OF ELECTROMAGNETIC BACKGROUND IN THE AREA OF NORTH BULGARIA
Nikolay Tashkov <sup>1</sup> , Svetoslav Yanakiev <sup>2</sup> <sup>1</sup> Technical University of Gabrovo, Bulgaria <sup>2</sup> Kozloduy NPP , Bulgaria
INTERFERENCES IN WIRELESS CHANNEL MODEL  OF A BODY AREA NETWORK 122  Srdjan Jovković <sup>1</sup> , Borivoje Milošević <sup>2</sup> , Slobodan Obradović <sup>3</sup> <sup>1</sup> College of Applied Technical Sciences, Niš, Serbia <sup>2</sup> Alfa University, Beograd, Serbia
3VISER, Beograd, Serbia  2BIQUAD ANTENNA DIMENSIONS OPTIMIZATION USING DESIGN OF EXPERIMENT THEORY
EXPERIMENTAL RESEARCH ON PARAMETERS AND CHARACTERISTICS OF SIGNALS IN THE DIGITAL SATELLITE TELEVISION
APPLICATION OF 5G NETWORKS IN VEHICLE-TO-VEHICLE WIRELESS COMMUNICATIONS
IMPROVED GRAY-SCALE WATERMARK ENCRYPTION  BASED ON CHAOTIC MAPS
ESTIMATING OPTIMAL VALUE OF PARAMETER 1P KEYS  KERNEL BY DSC ALGORITHM

SUBJECTIVE EVALUATION OF SPEECH INTELLIGIBILITY	
IN ORTHODOX CHURCH BASED OF THE TEST INTELLIGIBILITY	
NASALS, LATERALS AND AFFRICATES	156
Violeta Stojanović, Dijana Kostić, Zoran Milivojević, Zoran Veličković	
College of Applied Technical Sciences of Nis, Serbia	
PERFORMANCE OF FSO TRANSMISSION OF COLOR IMAGE	
OVER DOUBLE GENERALIZED GAMMA TURBULENCE CHANNEL	163
Bojan Prlinčević <sup>1</sup> , Stefan Panić <sup>2</sup> , Petar Spalević <sup>3</sup> , Aleksandra Kokić Arsić <sup>1</sup> , Bojana Milosavljević <sup>1</sup> , Khaled Mohamed Mohamed Hiamir Swhli <sup>o</sup> 'Higher Technical Professional School in Zvecan, Serbia,	1
<sup>2</sup> Faculty of Natural Science and Mathematics, University of Pristina, Serbia	
<sup>3</sup> Faculty of Technical Sciences, University of Pristina, Serbia	
<sup>o</sup> Univesity of Singidumun, Belgrade, Serbia	
OPTIMIZED GAIN ACHIEVEMENT AT EFFICIENCY OVER 90%	
AND MINIMIZED NOISE OF RFPOWER AMPLIFIERS	
BY S-PARAMETRIC CORRECTION	168
Iliya Nedelchev, Miroslav Tomov	
Technical University Gabrovo, Bulgaria	
SERBIAN SENTENCE MATRIX TEST FOR SPEECH INTELLIGIBILITY	
MEASUREMENT IN DIFFERENT REVERBERANT CONDITIONS	173
Zoran Milivojević <sup>1</sup> , Dijana Kostić <sup>1</sup> , Zoran Veličković <sup>1</sup> , Darko Brodić <sup>2</sup>	
'College of Applied Technical Sciences of Nis, Serbia	
<sup>2</sup> University of Belgrade, Technical Faculty in Bor, Serbia	
COMPLITER SYSTEMS	1
COMPUTER SYSTEMS	
COMPUTER SYSTEMS  THE K-NEAREST NEIGHBOUR CLASSIFIER	
<u> </u>	181
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović ****	
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović **** LidijaPaunović**	
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović **** LidijaPaunović**  *Belgrade Business School, Higher Education Institution	
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović ****  LidijaPaunović**  *Belgrade Business School, Higher Education Institution for Applied Science, Belgrade, Serbia	
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović ****  LidijaPaunović**  *Belgrade Business School, Higher Education Institution for Applied Science, Belgrade, Serbia  ** Faculty of Technical Science Cacak, University of Kragujevac, Cacak, Serbia  ***Faculty of Technical Science in Kosovska Mitrovica, University	
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović **** LidijaPaunović**  *Belgrade Business School, Higher Education Institution for Applied Science, Belgrade, Serbia  ** Faculty of Technical Science Cacak, University of Kragujevac, Cacak, Serbia  ***Faculty of Technical Science in Kosovska Mitrovica, University of Pristina, Kosovska Mitrovica, Serbia	
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović ****  LidijaPaunović**  *Belgrade Business School, Higher Education Institution for Applied Science, Belgrade, Serbia  ** Faculty of Technical Science Cacak, University of Kragujevac, Cacak, Serbia  ***Faculty of Technical Science in Kosovska Mitrovica, University	
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović **** LidijaPaunović**  *Belgrade Business School, Higher Education Institution for Applied Science, Belgrade, Serbia  ** Faculty of Technical Science Cacak, University of Kragujevac, Cacak, Serbia  ***Faculty of Technical Science in Kosovska Mitrovica, University of Pristina, Kosovska Mitrovica, Serbia  **** University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia  OPPORTUNITY FOR GRADING ON SHAPE SHELL NUTS	.,
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović **** LidijaPaunović**  *Belgrade Business School, Higher Education Institution for Applied Science, Belgrade, Serbia  ** Faculty of Technical Science Cacak, University of Kragujevac, Cacak, Serbia  ***Faculty of Technical Science in Kosovska Mitrovica, University of Pristina, Kosovska Mitrovica, Serbia  **** University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia  OPPORTUNITY FOR GRADING ON SHAPE SHELL NUTS BY IMAGE PROCESSING ON "VISION ASSISTENT"	.,
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović **** LidijaPaunović**  *Belgrade Business School, Higher Education Institution for Applied Science, Belgrade, Serbia  ** Faculty of Technical Science Cacak, University of Kragujevac, Cacak, Serbia  ***Faculty of Technical Science in Kosovska Mitrovica, University of Pristina, Kosovska Mitrovica, Serbia  **** University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia  OPPORTUNITY FOR GRADING ON SHAPE SHELL NUTS	.,
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović **** LidijaPaunović**  *Belgrade Business School, Higher Education Institution for Applied Science, Belgrade, Serbia  ** Faculty of Technical Science Cacak, University of Kragujevac, Cacak, Serbia  *** Faculty of Technical Science in Kosovska Mitrovica, University of Pristina, Kosovska Mitrovica, Serbia  **** University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia  OPPORTUNITY FOR GRADING ON SHAPE SHELL NUTS BY IMAGE PROCESSING ON "VISION ASSISTENT"  Angel Kansazov, Velina Kansazova, Nikolai Shopov	.,
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović **** LidijaPaunović**  *Belgrade Business School, Higher Education Institution for Applied Science, Belgrade, Serbia  ** Faculty of Technical Science Cacak, University of Kragujevac, Cacak, Serbia  ***Faculty of Technical Science in Kosovska Mitrovica, University of Pristina, Kosovska Mitrovica, Serbia  **** University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia  OPPORTUNITY FOR GRADING ON SHAPE SHELL NUTS BY IMAGE PROCESSING ON "VISION ASSISTENT"  Angel Kansazov, Velina Kansazova, Nikolai Shopov University of Food Technologies, Plovdiv, Bulgaria	187
THE K-NEAREST NEIGHBOUR CLASSIFIER WITH A WRAPPER-BASED FEATURE SELECTION  Jasmina D. Novakovic*, AlempijeVeljovic**, Sinisa S. Ilic***, MićaJovanović **** LidijaPaunović**  *Belgrade Business School, Higher Education Institution for Applied Science, Belgrade, Serbia  **Faculty of Technical Science Cacak, University of Kragujevac, Cacak, Serbia  ***Faculty of Technical Science in Kosovska Mitrovica, University of Pristina, Kosovska Mitrovica, Serbia  ***** University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia  OPPORTUNITY FOR GRADING ON SHAPE SHELL NUTS BY IMAGE PROCESSING ON "VISION ASSISTENT"  Angel Kansazov, Velina Kansazova, Nikolai Shopov University of Food Technologies, Plovdiv, Bulgaria  MODELING OF OPERATOR'S ACTIVITY IN CONTACT CENTER	187

TESTING A SET OF EXPERIMENTAL DATA	
FOR NORMAL PROBABILITY DISTRIBUTION	201
Petar Minev	
Technical University of Gabrovo, Bulgaria	
COMPUTER SYSTEM OF INTEGRATED CONTROL	
OF COLORS REGISTER IN SHEET-FED PRESSES	210
Morfliuk Valeriy, Karpenko Iryna	
Publishing and Printing Institute NTUU «Kyiv Polytechnic Institute»	
STRUCTURAL DECOMPOSITION OF GRAPHS MODELS	215
Matyo Stefanov Dinev	
Technical University of Gabrovo, Bulgaria	
COMPARISON OF PERFORMANCE IN DATA ANALYSIS	
IN DEDICATED AND TRADITIONAL DBMS	219
Siniša Ilić <sup>1</sup> , Dragiša Miljković <sup>1</sup> , Alempije Veljović <sup>2</sup> , Slobodan Obradović <sup>3</sup> , Bojan Jovanović <sup>0</sup>	
<sup>1</sup> Faculty of Technical Sciences, K. Mitrovica, Serbia	
<sup>2</sup> Faculty of Technical Sciences, Čačak	
<sup>3</sup> The School of El. and Comp. Engineering, Belgrade	
°The Technical School Uroševac, Leposavić	
ANALYSIS OF THE TIMER - COUNTER SYSTEMS EMBEDDED	
IN SINGLE-CHIP MICROCOMPUTERS	226
Borislav Petrov	
Technical University of Gabrovo, Bulgaria	
USING EMBEDDED SYSTEMS AS A DASHBOARD	232
Cem Taskin, Deniz Taskin, Ayşe Celik Taskin	
Trakya University, Turkey	
MODEL FOR DETERMINING THE WORKING ZONE	
OF PARALLEL PLACED ULTRASONIC SENSORS	236
Hristo Kilifarev, Ivan Simeonov, Raycho Ilarionov	
Technical University of Gabrovo, Bulgaria	
COMPUTER SYSTEM FOR IDENTIFICATION OF FRUIT JUICES	242
Nikolay Shopov <sup>1</sup> , Radoslav Vasilev <sup>1</sup> , Raycho Ilarionov <sup>2</sup> , Ivan Simeonov <sup>2</sup> , Angel	
Kansazov <sup>1</sup>	
<sup>1</sup> University of Food Technologies, Plovdiv	
<sup>2</sup> Technical University of Gabrovo, Bulgaria	
ALGORITHMS FOR SYNTHESIS OF FPGA	240
PROGRAMMABLE FREQUENCY DIVIDER	249
Borislav Petrov	
Technical University of Gabrovo, Bulgaria	

## COMPUTER TECHNOLOGIES

SYNTHESIS OF A CHAOTIC CODES INTO OBJECT-ORIENTATED LIBRARY FOR DATAENCRYPTION	257
Nadka Ivanova, Stanimir Yordanov, Elena Monova	257
Technical University of Gabrovo, Bulgaria	
NEURAL NETWORK-BASED EDUCATIONAL SUPPORT:	
LEARNING MANAGEMENT SYSTEM APPLICATION	262
Marija Blagojević <sup>1</sup> , Živadin Micić <sup>1</sup> , Zoran Ebersold <sup>2</sup>	
<sup>1</sup> Faculty of Technical Sciences Čačak, University of Kragujevac <sup>2</sup> University of Applied Sciences, Augsburg	
MULTISENSOR TEMPERATURE MEASUREMENT EXPERIMENTAL MODEL	267
Jordan Kanev, Delyan Genkov	
Technical University of Gabrovo, Bulgaria	
USABILITY ANALYSIS OF THE SPECIFIC CAPTCHA TYPES	272
Darko Brodić, Radmila Janković	
University of Belgrade, Technical Faculty in Bor, Serbia	
VIRTUAL MACHINE ENVIRONMENT FOR STUDY OF EMAIL SERVICES	278
Ilian Todorov	
Technical University of Gabrovo, Bulgaria	
INVESTIGATION OF DOS ATTACKS	282
Veneta Aleksieva, Ivaylo Zhelyazkov	
Technical University of Varna, Bulgaria	
IMPLEMENTATION OF FAST PARALLEL SORTING	
ALGORITHM WITH C AND MPI	287
Atanaska Bosakova-Ardenska, Miroslav Apostolov	
Unversity of Food Technologies, Plovdiv, dep. Computer Systems and Technologies	
DETECTION OF SECURITY TREATS FOR SOFTWARE INTENSIVE SYSTEMS.	292
Dimitar Dzhondzhorov¹, Aleksandar Dimov¹ 2	272
<sup>1</sup> Faculty of Mathematics and Informatics, University of Sofia	
<sup>2</sup> Institute of Mathematics and Informatics, Bulgarian Academy of Sciences	
INFORMATION TECHNOLOGY FOR THE FUNCTION'S	
DISTRIBUTION BETWEEN OPERATORS IN CONTROL SYSTEM	298
Lavrov E.A. <sup>1</sup> , Pasko N.B. <sup>2</sup>	
<sup>1</sup> Sumy State University (Ukraine)	
<sup>2</sup> Sumy National Agrarian University (Ukraine)	
DETECTION OF DANGEROUS MAGNETIC FIELD RANGES	
FROM TABLETS BY CLUSTERING ANALYSIS	305
Darko Brodić <sup>1</sup> , Alessia Amelio <sup>2</sup>	
<sup>1</sup> Technical Faculty in Bor, University of Belgrade, Serbia <sup>2</sup> Dimes University of Calabria, Italy	
Dimes University of Cataoria, Haly	

SECURITY ANALYSIS OF OPEN SOURCE DATABASES
IN WEB APPLICATION DEVELOPMENT
Popović <sup>1</sup>
University of Niš - Faculty of Electronic Engineering, Niš, Serbia <sup>1</sup> University of Criminalistic and Police Studies, Department of Informatics and Computing, Belgrade, Serbia
<sup>2</sup> University of Priština – Kosovska Mitrovica, Faculty of Economy, Kosovska Mitrovica, Serbia
INTRUSION PREVENTIG SYSTEM FOR NETWORK ATTACKS
A MODEL WHICH DETERMINES THE DISCOURSE COHERENCE
IN AUTISTIC INDIVIDUALS 322 Özlem Uçar, Aysun Çiftçi, Önder Açikgöz Trakya University, Tukey
OBTAINING PATH DATA FROM MAZE IMAGE
USING IMAGE PROCESSING TECHNIQUES 326 Ozan Aki, Aydın Güllü Trakya University, Tukey
EMMO - SYSTEM FOR ENERGY EFFICIENCY AND CUSTOMER ENGAGEMENT THROUGH BEHAVIORAL CHANGE 330 Andrey Bachvarov <sup>1</sup> , Petko Ruskov <sup>2</sup> 'BICA 2FMI, Sofia University, Bulgaria
SMART FEED PUSHER ROBOT DESIGN AND APPLICATION
<sup>2</sup> Trakya University
EXPLORING THE VALUE IN SOFTWARE ENGINEERING
FINDING THE OPTIMAL LOSSLESS COMPRESSION METHOD
FOR IMAGES USING MACHINE LEARNING ALGORITHMS 345 Emir Öztürk, Altan Mesut Computer Engineering Department Trakya University – Edirne / Turkey
STUDY OF VIDEOCONFERENCING SYSTEMS 349 Delyan Genkov, Jordan Kanev Technical University of Gabrovo, Bulgaria
ANNEX OF A CHAOTIC SYSTEM WITH ADAPTIVE SYNCHRONIZATION
INTO OBJECT -ORIENTATED LIBRARY FOR DATA ENCRYPTION

CONCEPT OF IOT SYSTEM FOR MONITORING CONDITIONS OF THERMAL COMFORT
Dušan Marković <sup>1</sup> , Dejan Vujičić <sup>2</sup> , Željko Jovanović <sup>2</sup> , Uroš Pešović <sup>2</sup> , Siniša Ranđić <sup>2</sup> , Dijana Jagodić <sup>2</sup>
<sup>1</sup> Faculty of Agronomy Čačak, University of Kragujevac, Serbia <sup>2</sup> Faculty of Technical Sciences Čačak, University of Kragujevac, Serbia
INFUENCE OF THE BLOCK SIZE IN COMPRESSION WITH BOOLEAN FUNCTION MINIMIZATION
Gergana Vasileva Spasova Technical University of Varna, Bulgaria
WAVELET-BASED CLASSIFICATION IN TERAHERTZ ANALYSIS OF SUGARS 371 Dimitar G. Valchev and Nikolay A. Shopov University of Food Technologies, Bulgaria
A BRIEF HISTORY OF VIDEO EDITING 375  Ivanka Valova Sofia University FJMC, Bulgaria
COMPUTER 3D MODELS CATALOG CREATION
MATHEMATICS, INFORMATICS AND INFORMATION SECURITY
MOBILE APPLICATION AS DISTRIBUTED COMPUTING SYSTEM
FOR ARTIFICIAL NEURAL NETWORKS TRAINING USED IN PERFECT INFORMATION GAMES
<b>Delyan Keremedchiev, Maria Barova, Petar Tomov</b> Institute of Information and Communication Technologies - Bulgarian Academy of Sciences Sofia, Bulgaria
A METHOD FOR FINDING THE EIGENVALUES OF $3\times3$ REAL MATRICES394
A.B. Andreev¹, M.R. Racheva² ¹Technical University of Gabrovo & IICC-BAS ²Technical University of Gabrovo, Bulgaria
OPTIMAL SOLUTIONS FOR ONE ADAPTIVE SEARCH PROBLEM 398 Mladen Manev Technical University of Gabrovo, Bulgaria
ASSESSMENT OF NON-LINEAR DISTORTION IN DIFFERENT DEGREES OF SIGNALS IN TELECOMMUNICATION SYSTEMS OF INFORMATION
RESEARCH OF RESISTANCE STEGANOGRAPHIC DIGITAL WATERMARK EMBEDDED IN THE VECTOR IMAGE

MODELING FOR THE ACTIVITY OF EXPERT GROUP IN THE INFORMATION WAR	412
Irina Degteva, Yrii Yarmenchuk	
Vinnytsia National Technical University, Ukraine	
RESEARCH PROBLEMS OF LEAK CHANNEL VOICE	
OVER STRAY ELECTROMAGNETIC RADIATION	417
Vitalii Kataev	
Vinnytsia National Technical University, Ukraine	
MODEL FOR INCREASING OF THE INFORMATION SECURITY	
FOR THE EUROPEAN COUNTRIES, WHICH ARE RECEIVING	
THE IMMIGRANTS FROM UNDEVELOPED COUNTRIES	421
Liliya O. Nikiforova, Anatoliy A. Shiyan	
Vinnytsia National Technical University, Ukraine	
EXPERIMENTAL STUDIES OF EFFICIENCY IMPROVING METHOD	
FOR QUANTUM CRYPTOGRAPHY	425
Sergiy Gnatyuk <sup>1</sup> , Tetyana Zhmurko <sup>1</sup> , Khalicha Yubuzova <sup>2</sup> <sup>1</sup> National Aviation University	
<sup>2</sup> Kazakh National Research Technical University named after K.I. Satpayev	
DIGITAL WATERMARKING IN SPATIAL DOMAIN	431
Željko Gavrić, Vanja Mišković	
Faculty of Information Technology, Slobomir P University, Republic of Srpska	
THE FLOW OF CONTROL INFORMATION	
IN A SECURE CORPORATE NETWORK OVERLOAD CONDITIONS	437
Marina Kostyak, Lubomir Parhutz	
Lviv Polytechnic National University, Ukraine	
SAFETY RECOMMENDATION SYSTEM FOR TOURIST TRIPS	442
V. Savchuk, V. Pasichnyk, N. Kunanec	
Lviv Polytechnic National University, Lviv, Ukraine	



## MOBILE APPLICATION AS DISTRIBUTED COMPUTING SYSTEM FOR ARTIFICIAL NEURAL NETWORKS TRAINING USED IN PERFECT INFORMATION GAMES

### Delyan Keremedchiev, Maria Barova, Petar Tomov

Institute of Information and Communication Technologies - Bulgarian Academy of Sciences "akad. Georgi Bonchev" Str., block. 2, 1113 Sofia, Bulgaria +35929793237, d keremedchiev@bas.bg

#### Abstract

Mobile devices are getting faster and faster nowadays and it is reasonable to use them for artificial neural networks training. The strongest advantage of mobile devices is their availability. Separation of a calculating task on different machines, connected by network, is known as distributed computing. There are different distributed computing platforms, like the most popular BOINC, created in Berkeley. The biggest difficulty in distributed computing platforms is heterogeneity of the computational nodes. The best way for solving computational nodes heterogeneity is touse well established technology like Android and Java by the client for computing. In this study an Android based distributed computing platform is presented. The platform is used for Artificial Neural Networks (ANN) training. Already trained ANN is used as computer opponent in a perfect information game (game in the class of combinatorial games).

**Keywords:** artificial neural networks, mobile devices, optimization, training

#### INTRODUCTION

Artificial neural networks (ANN) began their development back in 1943 with the development of Warren McCulloch and Walter Pitts [1]. In recent developments the most common model of ANN is a three-layer network with back propagation of error (BP). This type of ANN is a targeted weight graph. Each node has its own activity. The strength of the connections between nodes determines how you interact with individual nerve elements. Conventionally the network is divided into three layers. The first layer serves as the input from the external environment and is referred to as an input. The third layer provides information outside of the network to the external environment and is called output. Between input and output layer stands a hidden layer, which has an essential role in the operation of the network, but also hides uncertainties (for example the hidden layer size). In the classical three-layered model of ANN connections go only from input to output. Feedback is characteristic of recurrent ANN. The most frequent use of ANN is in tasks for classification or prediction[2][3]. The main task of the classic three-layer ANN is to correlate function between the input and the output. This process of comparison is called training. Training is a problem associated to finding such values of weights in the network that the network will perform the task for which it was designed. Once trained, ANN are extremely effective for use in practice. The learning process is slow and not very effective[4][5][6]. For the determination of optimal values of weights many learning developed algorithms are (exact approximated). Methods are based on gradient methods, evolutionary algorithms (EA) and heuristic approaches of global optimization [7][8][9][10][11]. When EA or population algorithms are used for training the training can be done in a parallel implementation or as calculations distributed in a tasks environment[12][13]. Big have application as calculations in a distributed environment. Not all calculations can be done in parallel but those that can are preferred for calculations in a distributed environment. In the modern development of mobile devices and more reliable and efficient network connectivity, ANN training in a mobile distributed environment becomes attractive. There are different platforms in a distributed

computing environment. The most popular is BOINC and the project SETI@home[14][15]. A major drawback of the most popular platforms for calculations in a distributed environment is the challenge to work in a heterogeneous environment where hardware and operating systems on individual computers in the system varies greatly. This shortcoming is brightly illustrated in BOINC platform. A creator of a project for distributed computing is responsible to write client programs for almost any configuration (hardware-operating system) that would like to be supported. Even the presence of 32 bit, 64 bit, Windows, Linux and Mac OS X systems leads to developing at least 6 different client applications. The variety of hardware and operating systems is a major problem for scalability of a platform for distributed computing environments. At the same time, high expandability of the system can be achieved if the calculations are carried out with technology that is widespread on different hardware platforms and operating systems such as Android operating system and the programming language Java. The second major disadvantage is the need for users to have a desktop or laptop computer. This disadvantage can be overcome by using the computing power of modern mobile devices.

### PROBLEM DESCRIPTION

There are different approaches for implementation of computer opponents in perfect information games. In information games opponents know everything in the game (in the general case there are two opponents). They have the whole necessary information to form an optimal strategy. The popular representative of perfect information games is chess in which both opponents see the playing board and all opponent's positions. Perfect information games are deterministic and can be completed in a finite number of moves. On completion of the full tree of states it is possible to determine optimal strategies for each player. The construction of the tree is a combinatorial problem and often leads to an impossible task due to the excessive state space. This approach makes complete depletion applicable and leads to demand for various heuristics to provide adequate strategy game without a thorough investigation of the states space. A step in this direction is the procedure of alpha-beta punching that allows not building the whole states tree. Some of the possible scenarios are to drop out at an early stage of the study. Another common approach is the use of empirical rules laid down in an expert system. The information set out in the expert system is processed by machine logical conclusion and thus determines the strategy of the game. The disadvantage of the approach with expert systems is that expert should introduce rules in the system and in fact the system does not have the capacity to accumulate knowledge alone. One way to overcome this deficiency is the use of artificial neural networks instead. The state of the playing board is submitted as an input for the ANN. The output of the ANN is the move to be played. In this study ANN is trained to play the game Complica[19]. The game consists of vertical columns in which each player places a piece of its color. The aim of the game is to form a line of four pieces the same color (orthogonally diagonally). The difference between Complica game and Connect Four game is that in the Complica game when a vertical column is full at the next placement of a piece it falls at the bottom of the board. This modification allows one player to beat even after the opponent's move. It is also possible two players to form a line of four simultaneously. Although the rules of the game are quite simple, creating a sufficiently skilled computer opponent is sufficiently complicated, especially when it comes to systems that need to learn and to adapt according increasing knowledge and skills of the opponents.

### MODEL DESCRIPTION

This study proposes a model for ANN training based on back propagation of error algorithm. BP is in the group of the exact gradient numerical methods. ANN training is done in a mobile distributed environment. The network is represented as a Java object from the library Encog[16]. The communication with the central calculating node (the server) is carried on using the HTTP protocol. The goal of the training is improvement of the computer

opponent in a game with perfect information[18].

For the purposes of move selection, a mathematical model is built. The base of the model is ANN, trained by BP in distributed computing. Classical three-layered ANN is used. The size of the input layer is determined by the size of the playing field (in this case 35 cells) and 4 inputs are added to determine one of the four computer opponents the network presents[18]. For the output layer 5 elements are used. The game requires to choose one column of five available. The size of the hidden layer in the ANN is a matter of experimental study. The model presented in the paper uses half the size of the input layer. The activation function is a linear activation function:

(1) 
$$u[i] = sum(w[i][j] * x[j])$$

The activation function defines the way the input signals in combination with the weighting factors influences the activity of the respective neuron. Although models with other types of activation functions are available at this stage preferences are in favor of the simplest model based on linearity.

The result of the activation function is necessarily normalized by a threshold function (a sigmoid function with values ranging from 0.0 to 1.0). Because of the different number of connections between different neurons output would perform differently if it is not normalized.

(2) 
$$x[i] = 1/(1 + \exp(-u[i]))$$

Sigmoid function is preferred for threshold function because it is differentiable and asymptotic to infinity. It is possible to use a binary function or a linear function (to improve performance) but their properties deviate the results that can be achieved by ANN. If the network is working with values from -1.0 to +1.0 a hyperbolic tangent can be used as a threshold function.

ANN training is carried out by unsupervised learning. During the game the mobile device accumulates a list of moves that make a particular player win . Such a database is used as a source of training examples.

Database (SQLite embedded database) is filled in with information for both the victories achieved by man and victories realized by computer opponents. ANN training can be organized in the form of competitions between different ANN, but since there is sufficient information from the external environment, it is not necessary.

The playing board consists of 5x7 cells. Each cell may be empty or may contain a piece with the color of one of the four players. These 5 different values are coded at the input of the 35 elements. A scaling function that scales integers from interval [0, 4] to real numbers in the range [0.0; 1.0] is used. At the input of the network four signals are further submitted. That determines one of the four players presented by the ANN. Three of these inputs are zeros (the opponents). The fourth one can be determined according to the player's number presented by the ANN.

ANN output makes assessment for prospects of each of the five possible moves. As according to the rules of the game there are no available moves the column to be played is estimated with 1.0 and the other with 0.0 in the learning mode. When the ANN is used in operational mode, the move is selected by a column with value assessment approximately 1.0.

There are many advantages of the proposed model. First, by using BP training ANN faster convergence of the process of training is achieved. The second advantage is the possibility to carry out training of three-layer ANN with different size of the hidden layer. The third advantage is the possibility to train ANN with a growing number of training examples by accumulating examples in the local database. The fourth advantage is the ability to train various copies of the ANN and to do so in parallel. Parallel training can result in improvement of performance and better coverage of the area to search.

The proposed model has some disadvantages. Training using ANN, is a very slow and difficult process. Although very effective, after being trained, ANN requires large amounts of computing resources. Using BP significantly limits the opportunities for recurrent

topologies compared with algorithms such as differential evolution or genetic algorithms. An interesting model is one that combines BP with heuristic algorithms from the group of population algorithms for global optimization. The development of distributed computing systems is significantly more complicated than developing linear programs and even more complicated than developing parallel programs. Nevertheless a purely technological trend exists.

### **EXPERIMENTS AND RESULTS**

The computer opponent, presented by the ANN, is opposed to three other opponents - a man, computer opponent based on random search (Random Search Optimization) and a computer opponent based on the system with five simple rules (Simple Rule Engine) [18].

For the purposes of the experiment, ANN is trained within a week. Four devices with Android operating system (two tablets and two telephones) were used. Two different people participated in 30 games on each device.

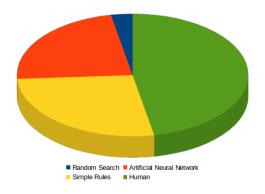


Fig. 1. Success of ANN compared to man, random search system and simple rules. The chart reflects the achieved victories in 100 games.

Player	Success
Random Search	3%
Artificial Neural Network	23%
Simple Rules	27%
Human	47%
Total	100%

Tab. 1. Success of ANN compared to man, random search system and simple rules. Number of wins in the 100 games.

ANN achieves better results than algorithms for random search, but weaker results than the five simple rules system based on 100

games played (Tab. 1 and Fig. 1). The results also indicate that the man was able to win almost a half of the games ANN training in a longer period of time would be an interesting task.

#### **CONCLUSION**

The realization of calculations in a distributed environment, as an Android system, leads to a very high degree of expandability in the system. Practically, distributed computing can run on any device supporting the Android operating system. Since the calculation is performed in the hardware with limited opportunities, the results cannot match the capabilities of desktop, mobile or super computers. Further experiments can be done with ANN topology as described in [17]. For distributed environment incident node participation can be used as described in [20] and [21]. For ANN training Differential Evolution can be used very successfully as described in [22].

### **ACKNOWLEDGMENTS**

This work was supported by private funding of Velbazhd Software LLC.

#### REFERENCE

- [1] McCulloch, Warren; Walter Pitts (1943), A Logical Calculus of Ideas Immanent in Nervous Activity, Bulletin of Mathematical Biophysics 5 (4): 115–133. doi:10.1007/BF02478259.
- [2] Zissis, Dimitrios (October 2015), A cloud based architecture capable of perceiving and predicting multiple vessel behaviour, Applied Soft Computing 35.
- [3] Forrest MD (April 2015), Simulation of alcohol action upon a detailed Purkinje neuron model and a simpler surrogate model that runs >400 times faster, BMC Neuroscience 16 (27). doi:10.1186/s12868-015-0162-6.
- [4] Werbos, P.J. (1975), Beyond Regression: New Tools for Prediction and Analysis in the Behavioral Sciences.
- [5] Schmidhuber, Jurgen (2015), Deep learning in neural networks: An overview, Neural Networks 61: 85–117. arXiv:1404.7828. doi:10.1016/j.neunet.2014.09.003.
- [6] Edwards, Chris (25 June 2015), Growing pains for deep learning", Communications of the ACM 58 (7): 14–16. doi:10.1145/2771283.

- [7] M. Forouzanfar, H. R. Dajani, V. Z. Groza, M. Bolic, and S. Rajan, (July 2010), Comparison of Feed-Forward Neural Network Training Algorithms for Oscillometric Blood Pressure Estimation, 4th Int. Workshop Soft Computing Applications. Arad, Romania: IEEE.
- [8] de Rigo, D., Castelletti, A., Rizzoli, A.E., Soncini-Sessa, R., Weber, E. (January 2005), A selective improvement technique for fastening Neuro-Dynamic Programming in Water Resources Network Management, In Pavel Zítek. Proceedings of the 16th IFAC World Congress IFAC-PapersOnLine. 16th IFAC World Congress. Prague, Czech Republic: IFAC. doi:10.3182/20050703-6-CZ-1902.02172. ISBN 978-3-902661-75-3. Retrieved 30 December 2011.
- [9] Ferreira, C. (2006), Designing Neural Networks Using Gene Expression Programming, In A. Abraham, B. de Baets, M. Köppen, and B. Nickolay, eds., Applied Soft Computing Technologies: The Challenge of Complexity, pages 517–536, Springer-Verlag.
- [10] Da, Y., Xiurun, G. (July 2005), T. Villmann, ed. An improved PSO-based ANN with simulated annealing technique. New Aspects in Neurocomputing, 11th European Symposium on Artificial Neural Networks. Elsevier. doi:10.1016/j.neucom.2004.07.002.
- [11] Wu, J., Chen, E. (May 2009). Wang, H., Shen, Y., Huang, T., Zeng, Z., ed. A Novel Nonparametric Regression Ensemble for Rainfall Forecasting Using Particle Swarm Optimization Technique Coupled with Artificial Neural Network, 6th International Symposium on Neural Networks, ISNN 2009. Springer. doi:10.1007/978-3-642-01513-7-6. ISBN 978-3-642-01215-0.
- [12] Rumelhart, D.E; James McClelland (1986), Parallel Distributed Processing: Explorations in the Microstructure of Cognition. Cambridge, MIT Press.
- [13] Russell, Ingrid, Neural Networks Module, Retrieved 2012.
- [14] D. P. Anderson, J. Cobb, E. Korpela, M. Lebofsky, and D. Werthimer, SETI@home: An experiment in public-resource computing,

- Communications of the ACM, Nov. 2002, Vol. 45 No. 11, pp. 56-61.
- [15] D. Anderson. BOINC, A System for Public-Resource Computing and Storage, In proceedings of the 5th IEEE/ACM International GRID Workshop, Pittsburgh, USA, 2004.
- [16] Encog Machine Learning Framework, http://www.heatonresearch.com/encog/
- [17] Zankinski I. Stoilov T. The effect of permutations of neurons in training artificial neural networks, genetic algorithms in a distributed environment, Proceedings of the XXIV International Symposium Management warm energy facilities and systems, energy management, industrial and environmental systems, ISSN 1313-2237, pp. 53-55.
- [18] Balabanov, T., Complica4 Android modification of the original board game Complica, https://raw.githubusercontent.com/VelbazhdSof twareLLC/Complica4/master/src/eu/veldsoft/complica4/model/ia/NeuralNetworkArtificialIntelligence.java
- [19] Pro Ligno Spielewerkstatt, Complica, https://boardgamegeek.com/boardgame/7476/complica
- [20] Balabanov, T., Zankinski, I., Barova, M., Strategy for Individuals Distribution by Incident Nodes Participation in Star Topology of Distributed Evolutionary Algorithms, Cybernetics and Information Technologies, Vol. 16 No 1, ISSN: 1314-4081, 2016.
- [21] Balabanov, T., Zankinski, I., Barova, M., Distributed Evolutionary Computing Migration Strategy by Incident Node Participation, International Conference on Large-Scale Scientific Computing, 10th International Conference, LSSC 2015, Sozopol, Bulgaria, June 8-12, ISBN 978-3-319-26519-3, pp. 203-209, 2015.
- [22] Balabanov, T., Zankinski, I., Dobrinkova, N., Time Series Prediction by Artificial Neural Networks and Differential Evolution in Distributed Environment, International Conference on Large-Scale Scientific Computing, 8th International Conference, LSSC 2011, Sozopol, Bulgaria, June 6-10, ISBN 978-3-642-29842-4, pp. 198-205, 2011.