

BI  **ICT**

IT'16
ŽABLJAK

XXI

međunarodni naučno - stručni skup

**INFORMACIONE
TEHNOLOGIJE**

SADAŠNJOST I BUDUĆNOST

Urednik
Božo Krstajić

IT'16

**INFORMACIONE
TEHNOLOGIJE**

- SADAŠNJOST I BUDUĆNOST -

Urednik
Božo Krstajić

*Zbornik radova sa XXI međunarodnog naučno - stručnog skupa
INFORMACIONE TEHNOLOGIJE - sadašnjost i budućnost
održanog na Žabljaku od 29. februara do 05. marta 2016. godine*

Zbornik radova
INFORMACIONE TEHNOLOGIJE - sadašnjost i budućnost 2016

Glavni urednik
Prof. dr Božo Krstajić

Izdavač
Univerzitet Crne Gore
Elektrotehnički fakultet
Džordža Vašingtona bb., Podgorica
www.etf.ucg.ac.me

Tehnička obrada
Aleksandra Radulović
Centar informacionog sistema
Univerziteta Crne Gore

Tiraž
150

Podgorica 2016.

Sva prava zadržava izdavač i autori

Organizator

Elektrotehnički fakultet, Univerzitet Crne Gore

Suorganizatori:

BIO-ICT Centar izvrsnosti

Skup su podržali:

Ministarstvo za informaciono društvo i telekomunikacije

Ministarstvo nauke

Programski odbor

Dr Novak Jauković, Elektrotehnički fakultet, Podgorica, MNE
Dr Ljubiša Stanković, Elektrotehnički fakultet, Podgorica, MNE
Dr Zdravko Uskoković, Elektrotehnički fakultet, Podgorica, MNE
Dr Vujica Lazović, Ekonomski fakultet, Podgorica, MNE
Dr Branko Kovačević, Elektrotehnički fakultet, Beograd, SRB
Dr Milorad Božić, Elektrotehnički fakultet, Banja Luka, BIH
Dr Miroslav Bojović, Elektrotehnički fakultet, Beograd, SRB
Dr Zoran Jovanović, Elektrotehnički fakultet, Beograd, SRB
Dr Milica Pejanović-Đurišić, Elektrotehnički fakultet, Podgorica, MNE
Dr Despina Anastasiadou, Research & Development Innovation Academy, Solun, GRC
Dr Dejan Popović, Elektrotehnički fakultet, Beograd, SRB
Dr Gabriel Neagu, National Institute for Research & Development in Informatics, Bucharest, ROU
Dr Božo Krstajić, Elektrotehnički fakultet, Podgorica, MNE
Dr Tomo Popović, Elektrotehnički fakultet, Podgorica, MNE
Dr Milovan Radulović, Elektrotehnički fakultet, Podgorica, MNE
Dr Le Xie, Texas A&M University, College Station, TX, USA
Dr Sašo Gelev, Elektrotehnički fakultet, Radoviš, MKD
Dr Budimir Lutovac, Elektrotehnički fakultet, Podgorica, MNE
Dr Igor Radusinović, Elektrotehnički fakultet, Podgorica, MNE
Dr Alex Sprintson, Texas A&M University, College Station, TX, USA
Dr Nikša Tadić, Elektrotehnički fakultet, Podgorica, MNE
Dr Miloš Daković, Elektrotehnički fakultet, Podgorica, MNE
Dr Milutin Radonjić, Elektrotehnički fakultet, Podgorica, MNE
Dr Ana Jovanović, Elektrotehnički fakultet, Podgorica, MNE
Dr Vesna Rubežić, Elektrotehnički fakultet, Podgorica, MNE
Dr Ramo Šendelj, Fakultet za Informacione Tehnologije, Podgorica, MNE
Dr Stevan Šćepanović, Prirodno-matematički fakultet, Podgorica, MNE

Organizacioni odbor

Dr Božo Krstajić, Elektrotehnički fakultet, Podgorica, MNE
Dr Milovan Radulović, Elektrotehnički fakultet, Podgorica, MNE
Dr Zoran Veljović, Elektrotehnički fakultet, Podgorica, MNE
Dr Ana Jovanović, Elektrotehnički fakultet, Podgorica, MNE
Dr Saša Mujović, Elektrotehnički fakultet, Podgorica, MNE
Dr Tomo Popović, Elektrotehnički fakultet, Podgorica, MNE
Dr Žarko Zečević, Elektrotehnički fakultet, Podgorica, MNE
Vladan Tabaš, dipl.ing., Čikom, Podgorica, MNE

Sekretarijat

Aleksandra Radulović, CIS Univerzitet Crne Gore, MNE

P R E D G O V O R

Poštovani učesnici i čitaoci,

Čitate XXI zbornik radova Međunarodnog naučno-stručnog skupa "INFORMACIONE TEHNOLOGIJE – sadašnjost i budućnost" (IT'16) koji je uspješno održan od 29. februara do 05. marta 2016. godine na Žabljaku. Programski odbor je izvršio selekciju kvalitetnih radova koji su prezentovani i publikovani ovdje, a najbolji (prema ocjenama recenzenata) će biti prošireni i objavljeni u časopisu Elektrotehničkog fakulteta Univerziteta Crne Gore ("ETF Journal of Electrical Engineering").

Šta bih izvdjio kao karakteristiku ovogodišnjeg Skupa i samih radova koji su pred vama. Prije svega, tematsku obojenost konferencije i velikog broja autorskih radova bioinformatikom kao jednim od savremenih pravaca razvoja ICT-a i nauke uopšte. Ovome je poseban doprinos dao prvi Centar izvrsnosti u oblasti bioinformatike u Crnoj Gori koji je bio suorganizator ovogodišnje konferencije. Rezultati multidisciplinarnih istraživanja i prezentacija inovativnih rješenja BIO-ICT centra izvrsnosti, koja su rezultat saradnje i rada više naučno-istraživačkih institucija i partnera iz inostranstva, su pobudili najviše interesovanja i dali dodatni kvalitet Skupu.

I ove godine je nastavljeno tradicionalno učešće studenata na Skupu. Novi kvalitet je da su, pored studenata ETF-a, učestvovali u radu i studenti druga dva univerziteta - "Univerzitet Mediteran" i "Univerzitet Donja Gorica". Studentske aktivnosti su obilovale temama i gostima, a cilj studentske sekcije je bilo motivisanje studenata za uključivanjem u naučno-istraživački rad i predstavljanje dijela mogućnosti koje im se nude.

Na kraju, treba dodati, da je Durmitor i ove godine bio nestvarno topao prema učesnicima i u bukvalnom i u prenosnom značenju. Snijega je bilo taman za slikanje, temperature su bile prolječne i ugodne za šetnju, a gostoprimstvo i druženje u skladu sa vremenom.

Sve detalje o ovom, prošlim i narednom skupu možete naći na web adresi konferencije www.it.ac.me.

Prof. dr Božo Krstajić

SADRŽAJ

Mirjana Kranjac (<i>Rad po pozivu</i>) STRATEŠKI RAZVOJ NA PRINCIPIMA PAMETNE SPECIJALIZACIJE, PRIMER VOJVODINE STRATEGIC DEVELOPMENT BASED ON PRINIPLS OF SMART SPECIALIZATION, CASE OF VOJVODINA.....	1
Jelena Ljucović, Tripo Matijević, Snežana Šćepanović, Ranka Stanković, Ivan Obradović REALIZACIJA PLATFORME ZA POVEZIVANJE AKADEMSKOG I PRIVREDNOG SEKTORA PRIMJENOM OTVORENIH OBRAZOVNIH RESURSA REALIZATION OF PLATFORM FOR BLENDING ACADEMIC AND ENTREPRENEURIAL SECTOR BY USING OPEN EDUCATIONAL RESOURCES	6
Snežana Šćepanović, Ivan Mraković PRIMJENA AMOS EMS APLIKATIVNOG SOFTVERA U PROCESU UPRAVLJANJA SOFTVERSKIM ZAHTJEVIMA USAGE OF AMOS EMS APPLICATION SOFTWARE IN PROCESS OF SOFTWARE REQUIREMENTS MANAGEMENT	10
Jelena Šuh, Jelena Petrović PRIMENA KONCEPTA BLENDED UČENJA U KORPORATIVNOM OKRUŽENJU TELEKOMUNIKACIONE KOMPANIJE IMPLEMENTATION OF THE BLENDED LEARNING CONCEPT IN A CORPORATE ENVIRONMENT OF TELECOMMUNICATION COMPANY	14
Mladen Bukilić, Tripo Matijević SKENIRANJE RANJIVOSTI INFORMACIONOG SISTEMA KORIŠĆENJEM OPEN SOURCE ALATA VULNERABILITY SCANNING OF INFORMATION SYSTEM USING OPEN SOURCE TOOLS.....	18
Hristina Bojović, Bratislav Bojović, Risto Bojović ZNAČAJ IT ZA IZOLOVANE ZAJEDNICE IMPORTANCE OF IT FOR ISOLATED COMMUNITIES	22
Gordana Laštovička-Medin STEAM PEDAGOGY & ICT ENHANCED LEARNING: BOE-BOT ROBOT, YOUTUBE AND PARALLAX'S FORUMS AS WEB-ENABLED MENTORS STEAM PEDAGOGIJA & UNAPRIJEDJENO UČENJE ICT TEHNOLOGIJOM: BOE-BOT ROBOT, YOUTUBE I PARALLAX FORUMI KAO WEB MENTORI.....	26
Gordana Laštovička-Medin LEARNING COREOGRAPHY AS INTERPLAY OF SCIENTIFIC AND AESTHETIC DIMENSION OF KNOWING: CRAFTING KNOWLEDGE WITH CONDUCTIVE PAINT AND MICROCONTROLLERS KOREOGRAFIJA UČENJA KAO INTERPLEJ NAUČNE I ESTETSKE DIMENZIJE SAZNAVANJA: KRAFTING ZNANJA POMOCU PROVODNE BOJE I MIKROKONTROLORA	30

Gordana Laštovička-Medin EMERGING INTERFACES FOR CONCEPTUAL CHANGE: CO-DESIGNING MODEL OF COOPERATION OF LEARNER, ARTIFACT – LEGO NXT AND REMOTE LAB EMERGING INTERFEJSI ZA KONCEPTUALNE PROMJENE: KODIZAJNIRANI MODEL KOOPERACIJE UČENIKA, ARTIFACTA – LEGO NXT I UDALJENE LABORATORIJE	34
Vasilija Šarac, Sašo Gelev, Goce Stefanov, Vlatko Čingoski PRIMENA PROGRAMSKOG PAKETA PSIM U SIMULACIJI ENERGETSKIH PRETVARAČA APPLICATION OF SOFTWARE PSIM IN SIMULATION OF POWER CONVERTERS	38
Sanja Bauk IoT PRIMJENE I NJIHOV UTICAJU NA DIGITALNU PODJELU IoT's APPLICATIONS AND THEIR IMPACT ON DIGITAL DIVIDE	42
Aleksandar Ristić, Sandra Ristić ŠKOLSKI I POSLIJEŠKOLSKI PROGRAMI – INFORMACIONO DRUŠTVO REPUBLIKE SRPSKE SCHOOL AND AFTERSCHOOL PROGRAMS – IT SOCIETY OF REPUBLIC OF SRPSKA	46
Maja Kukusheva Paneva, Biljana Chitkusheva Dimitrovska, Goce Stefanov, Vasilija Šarac PRIMENA PROGRAMSKOG PAKETA PSIM U PROUČAVANJA DIODNOG ISPRAVLJAČA PSIM AS EDUCATIONAL TOOL FOR TEACHING DIODE RECTIFIER	50
Marko Bošković UMREŽENI UPRAVLJAČKI SISTEMI NETWORKED CONTROL SYSTEMS.....	53
Tomislav B. Šekara, Marko Bošković, Milovan Radulović, Boško Cvetković NOVA METODA ZA OPTIMIZACIJU PIDC REGULATORA POD OGRANIČENJIMA NA PRETEK FAZE I OSJETLJIVOST NA MJERNI ŠUM A NOVEL METHOD FOR OPTIMIZATION OF PIDC REGULATORS UNDER CONSTRAINTS ON PHASE MARGIN AND SENSITIVITY TO MEASUREMENT NOISE	57
Marko Bursać, Goran Tričković, Radislav Vulović PROJEKTOVANJE INFORMACIONOG SISTEMA ZA AUTOMATIZACIJU POSLOVNIH PROCESA RADIO LOKOMOTIVSKIH UREĐAJA DESIGN INFORMATION SYSTEM FOR AUTOMATION BUSINESS PROCESSES OF RADIO LOCOMOTIVE DEVICES	61
Bojan Ćuković, Saša Mujović NEOVLAŠĆENO KORIŠĆENJE ELEKTRIČNE ENERGIJE U USLOVIMA PRIMJENE BROJILA NA DALJINSKO OČITAVANJE UNAUTHORIZED USE OF ELECTRICITY IN TERMS OF APPLICATION OF SMART METERS	65
Boško Cvetković, Mihailo Lazarević, Taško Maneski, Petar Mandić, Budimir Lutovac, Tomislav B. Šekara AKVIZICIJA PODATAKA KORIŠĆENJEM RAZVOJNE PLOČE RASPBERRY PI MODEL B DATA ACQUISITION USING SINGLE BOARD COMPUTER RASPBERRY PI MODEL B	69
Duško Parezanović, Dragan Vidaković PRAKSA RSA ŠIFROVANJA THE PRACTICE OF RSA ENCRYPTION	73

Žarko Zečević, Tomo Popović, Zdravko Uskoković, Božo Krstajić ALGORITAM ZA ESTIMACIJU SINHROFAZORA I FREKVENCIJE SYNCHROPHASOR AND FREQUENCY ESTIMATION ALGORITHM.....	77
Aleksandar Sošić MACHINE-TO-MACHINE KOMUNIKACIJA U LTE-ADVANCED MREŽAMA MACHINE-TO-MACHINE COMMUNICATIONS IN LTE-ADVANCED NETWORKS.....	81
Alija Dervić, Nikša Tadić, Milena Erceg KONTROLABILNI STRUJNI POJAČAVAČ U CMOS TEHNOLOGIJI OPTIMIZOVAN ZA PRIMJENE U OPTO-ELEKTRONSKIM INFORMACIONO-KOMUNIKACIONIM TEHNOLOGIJAMA CMOS CONTROLLABLE CURRENT AMPLIFIER OPTIMIZED FOR OPTO-ELECTRONIC INFORMATION AND COMMUNICATION TECHNOLOGIES.....	85
Milan Mišić, Bojan Prlinčević, Stefan Panić, Petar Spalević, Bojana Milosavljević ZAVISNOST PERFORMANSI PRENOSA SLIKE POŽARA KROZ RICIJAN FSO KANAL OD INDEKSA SCINCILACIJE DEPENDENSE OF PERFORMANCE FSO TRANSMISSION ON IMAGE FIRE DETECTION OVER RICEAN TURBULENCE CHANNELS OF ON SCINCILACION INDEX.....	89
Aleksandar Dedić, Budimir Lutova JEDAN PRIMJER HARDVERSKO REALIZACIJE FIR FILTRA KORIŠĆENJEM MIKROKONTROLERA AN EXAMPLE OF HARDWARE INPLEMENTATION OF A FIR FILTER USING A MICROCONTROLLER	93
Aleksandar Milenković, Dragan Janković, Miloš Marjanović, Petar Rajković PREDLOG HARDVERSKO-SOFTVERSKOG MODULA ZA EVIDENTIRANJE DOLASKA PACIJENATA U ČEKAONICI IZABRANOG LEKARA UPOTREBOM RFID TEHNOLOGIJE PROPOSAL FOR HARDWARE-SOFTWARE MODULE FOR RECORDING ARRIVAL OF PATIENTS IN THE WAITING ROOM OF THE CHOSEN DOCTOR BY USING RFID TECHNOLOGY	97
Violeta Stojanović, Dijana Kostić, Zoran Milivojević, Zoran Veličković OCENA SUBJEKTIVNE RAZUMLJIVOSTI CVC LOGATOMA U AMBIJENTU PRAVOSLAVNE CRKVE ASSESSMENT OF THE SUBJECTIVE INTELLIGIBILITY OF CVC LOGATOMS IN THE ENVIRONMENT OF ORTHODOX CHURCH	101
Zoran Veličković, Zoran Milivojević, Miloško Jevtović UTICAJ PREDIKCIONIH STRUKTURA H.264 KODERA NA KVALITET EKSTRAHOVANOG VODENOG ŽIGA IZ HAOS DOMENA THE EFFECT OF PREDICTION STRUCTURES H.264 ENCODER TO QUALITY OF EXTRACTED WATERMARK FROM THE CHAOS DOMAIN.....	105
Nataša Savić, Zoran Milivojević, Dejan Blagojević, Darko Brodić OPTIMIZACIJA PARAMETRA GREVILLE-OVOG INTERPOLACIONOG JEZGRA U SPEKTRALNOM DOMENU OPTIMIZATION OF THE PARAMETER OF GREVILLE INTERPOLATION KERNEL IN THE SPECTRAL DOMAIN	109

Zoran Milivojević, Dejan Blagojević, Marina Milivojević PERCEPTUALNA EFIKASNOST DISPLEJA MOBILNIH TELEFONA SONY XPERIA THE PERCEPTUAL EFFICIENCY OF THE DISPLAY OF SONY XPERIA MOBILE.....	113
Tomo Popović, Milutin Radonjić, Žarko Zečević, Božo Krstajić JEDNO IOT CLOUD RJEŠENJE NA BAZI OPEN SOURCE ALATA AN IOT CLOUD SOLUTION BASED ON OPEN SOURCE TOOLS	117
Ana Miletić, Aleksandra Radulović, Božo Krstajić “ZELENA” RAČUNARSKA UČIONICA THE GREEN COMPUTER ROOM.....	121
Nataša Popović, Tomo Popović FRAKTALNA ANALIZA DIGITALNIH SLIKA RETINE FRACTAL ANALYSIS OF DIGITAL IMAGES OF RETINA	125
Jelena Končar, Sonja Leković ANALYSIS OF MAIN CONDITIONS FOR DEVELOPMENT AND IMPLEMENTATION OF ELECTRONIC COMMERCE IN THE REPUBLIC OF SERBIA ANALIZA OSNOVNIH USLOVA ZA RAZVOJA I PRIMENU ELEKTRONSKE TRGOVINE U REPUBLICI SRBIJI	129
Eleonora Milić, Milena Stanković KORIŠĆENJE WEB SOKETA ZA PRIKUPLJANJE PODATAKA U REALNOM VREMENU NA WEB-U USING THE WEB SOCKETS FOR REAL TIME DATA COLLECTION ON THE WEB	133
Ana Miletić, Slavica Tomović, Igor Radusinović SOFTVERSKI DEFINISANA INFRASTRUKTURA ZA MOBILNI CLOUD A SOFTWARE DEFINED INFRASTRUCTURE FOR THE MOBILE CLOUD	137
Miloš Kosanović, Mirko Kosanović PRIMENLJIVOST RESTful WEB SERVISA U BEŽIČNIM SENZORSKIM MREŽAMA APPLICABILITY OF RESTful WEB SERVICES IN WIRELESS SENSOR NETWORKS	141
Katerina Cekova, Sašo Gelev BLUETOOTH UPRAVLJANJE MOBILNIM ROBOTOM CONTROLLING MOBILE ROBOT VIA BLUETOOTH	145
Jasna Cekova, Blagoj Delipetrev SISTEM ZA ZDRAVSTVENO PRAĆENJE KORIŠĆENJEM MOBILNIH TELEFONA I NOSIVIH UREĐAJA HEALTH MONITORING SYSTEM USING MOBILE PHONES AND WEARABLE DEVICES	149
Aleksa Srdanov, Dragan Milovanović DEKOMPOZICIJA ALGORITMA ZA REŠAVANJE SUDOKUA DECOMPOSITION OF SUDOKU ALGORITHM	153
Aleksa Srdanov, Nada Ratković Kovačević NEODLUČIVOST U PROBLEMIMA VEŠTAČKE INTELIGENCIJE UNDECIDABILITY IN PROBLEMS OF ARTIFICIAL INTELLIGENCE.....	157

Radiša Stefanović, Aleksa Srdanov POBOLJŠANJE EFIKASNOSTI ALGORITMA BEZ IZMENE KODA IMPROVING EFFICIENCY ALGORITHM WITHOUT CHANGES CODE.....	161
Petar Sekulić, Milija Bajčeta, Vesna Popović-Bugarin, Slobodan Đukanović, Andrej Mihailović JEDAN PRISTUP OPTIMIZACIJI GRADSKOG SAOBRAĆAJA ONE APPROACH TO THE OPTIMIZATION OF PUBLIC TRANSPORT.....	165
Petar Sekulić, Slobodan Đukanović, Igor Đurović PRIMJENA METODE VEKTORA NOSAČA U DETEKCIJI PLAMENJAČE VINOVE LOZE DETECTION OF DOWNY MILDEW IN GRAPEVINE LEAVES USING SUPPORT VECTOR MACHINE	169
Elma Hot, Vesna Popović-Bugarin ANALIZA FUZZY K-MEANS KLASERIZACIJE KORISTEĆI PEDOLOŠKU BAZU PODATAKA CRNE GORE ANALYSIS OF FUZZY K-MEANS CLUSTERING METHOD USING DATABASE OF SOIL SAMPLES SAMPLED IN MONTENEGRO	173
Nikola Bulatović, Trifun Savić, Nikola Žarić, Ana Pešić, Aleksandar Joksimović, Marko Nikolić MONITORING OF SEA WATER PARAMETERS – “SMART BUOY” SYSTEM DEVELOPMENT MONITORING PARAMETARA MORSKE VODE – RAZVOJ SISTEMA "PAMETNA BOVA"	177
Trifun Savić, Milutin Radonjić PREDLOG RJEŠENJA ZA DALJINSKU KONTROLU PUTEM INTERNET APLIKACIJE ONE SOLUTION FOR REMOTE CONTROL THROUGH INTERNET APPLICATION	181
Stefan Vujović, Miloš Brajović, Vesna Popović-Bugarin, Nedeljko Latinović, Jelena Latinović, Milija Bajčeta WEB SERVIS ZA MONITORING VINOGRADA I PREDVIĐANJE OBOLJENJA VINOVE LOZE A WEB SERVICE FOR GRAPEVINE MONITORING AND FORECASTING A DISEASE	185
Miloš Brajović, Stefan Vujović, Vesna Popović-Bugarin, Slobodan Đukanović, Mirko Knežević, Ana Topalović BAZA PODATAKA ZA ANALIZU ZEMLJIŠTA I EKSPERTNI SISTEM ZA DAVANJE PREPORUKA ZA ĐUBRENJE POLJOPRIVREDNIH KULTURA SOIL ANALYSIS DATABASE AND THE EXPERT SYSTEM FOR RECOMMENDATIONS OF FERTILIZATION IN AGRICULTURE.....	189
Vlatko Cingoski, Saso Gelev, Goce Stefanov, Vasilija Sarac INTEGRIRANE SOLARNE TERMoeLEKTRANE: SLUCAJ TE BITOLJ INTEGRATED SOLAR-THERMAL POWER PLANTS: TPP BITOLA CASE STUDY	193
Vladan Durković, Željko Đurišić IDEJNO REŠENJE I EKONOMSKA OPRAVDANOST IZGRADNJE FOTONAPONSKE ELEKTRANE NA KROVU LABORATORIJE TEHNIČKIH FAKULTETA U PODGORICI CONCEPTUAL DESIGN AND ECONOMIC FEASIBILITY OF BUILDING ROOF TOP PHOTOVOLTAIC POWER PLANT ON THE LABORATORY OF TECHNICAL FACULTY IN PODGORICA	197

Biljana Petrevska, Vlatko Cingoski, Saso Gelev OD PAMETNIH SOBA DO PAMETNIH HOTELA FROM SMART ROOMS TO SMART HOTELS	201
Nebojša Delibašić, Novak Jauković, Milovan Radulović KOMUNIKACIONI PROTOKOLI U INTELIGENTNIM OBJEKTIMA COMMUNICATION PROTOCOLS IN INTELLIGENT BUILDINGS	205
Ana Grbović CFC U STEP7 OKRUŽENJU - INTERKONEKCIJA I PARAMETRIZACIJA UMJESTO PROGRAMIRANJA CFC IN THE STEP 7 ENVIRONMENT - INTERCONNECTION AND PARAMETERIZATION INSTEAD OF PROGRAMMING	209
Kenan Duraković, Ramo Šendelj ANALIZA SAJBER INCIDENATA U CRNOJ GORI ANALYSIS OF CYBER SECURITY INCIDENTS IN MONTENEGRO.....	213
Saso Gelev, Goce Stefanov, Vlatko Cingoski, Vasilija Šarac DETEKCIJA I IZOLACIJA NEISPRAVNOSTI U SISTEMIMA AUTOMATSKOG UPRAVLJANJA SYSTEMS FOR DETECTION AND IDENTIFICATION OF AUTOMATION SYSTEM FALURES	217
Tijana Radulović, Luka Lazović, Ana Jovanović, Vesna Rubežić HAOS U MIKROTALASNOM KOLPICOVOM OSCILATORU CHAOS IN MICROWAVE COLPITTS OSCILLATOR	221
Marko Babić, Luka Lazović, Ana Jovanović, Vesna Rubežić HAOTIČNA DINAMIKA U VIBRACIJAMA NA HELIKOPTERU CHAOTIC DYNAMICS IN HELICOPTERS VIBRATIONS	225
Luka Lazović, Ana Jovanović, Vesna Rubežić, Dragan Filipović IMPLEMENTACIJA SOFTVERSKOG PAKETA AWR ZA PROJEKTOVANJE MIKROTALASNIH FILTARA IMPLEMENTATION OF AWR FOR MICROWAVE FILTER DESIGN	229
Luka Lazović, Žarko Zečević, Vesna Rubežić, Ana Jovanović PREDLOG ALGORITMA ZA ADAPTIVNI BEAMFORMING A NEW ALGORITHM FOR ADAPTIVE BEAMFORMING	233
Arsenije Maliković, Milica Ljumović, Dragan Filipović IMPLEMENTACIJA WIPL-D SOFTVERSKOG PAKETA U PROJEKTOVANJE MULTISEKCIONOG ČEBIŠLJEVLJEVOG TRANSFORMATORA IMPLEMENTATION OF WIPL-D SOFTWARE PACKAGE IN CHEBYSHEV MULTISECTION MATCHING TRANSFORMER DESIGN	237
Jelena Šoškić, Budimir Lutovac, Dragan Filipović ANALIZA PATCH ANTENE NA OSNOVU REZONATORSKOG MODELA PATCH ANTENNA ANALYSIS BASED ON CAVITY MODEL	241

BLUETOOTH UPRAVLJANJE MOBILNIM ROBOTOM CONTROLLING MOBILE ROBOT VIA BLUETOOTH

Katerina Cekova, *Faculty of Computer Science, UGD - Stip, R.Macedonia*
Sašo Gelev, *Faculty of Electrical Engineering, UGD - Stip, R.Macedonia*

Sadržaj: *Ovaj rad opisuje hardversku arhitekturu robota, kao i dizajn i implementaciju Android i Windows aplikacija. Komunikacija između mobilnog telefona i mobilnog robota ostvaruje se Bluetooth aplikacijom. Mobilni robot se upravlja aplikacijom. Aplikacija šalje poruku robotu za okretanje levo, desno, napred ili nazad kao i zaustavljanje. Mobilni robot je sastavljen od Bluetooth modula, Arduino Uno, dva DC motora, žice za povezivanje i Breadboard.*

Abstract: *This paper describes hardware architecture of mobile robot, design and implementation of Android and Windows applications. It is use Bluetooth communication between mobile phone and mobile robot. The mobile robot is control by applications. Applications send message to the mobile robot to turn left, right or move forward or backward and to stop. The mobile robot is composed of Bluetooth module, Arduino Uno, H-Bridge, two DC motors, jumper wires and Breadboard.*

1. INTRODUCTION

Robots are smart programmed machines and used in many areas such as industry, production lines or health. Today human-machine interaction is moving away from mouse and pen and is becoming pervasive and much more compatible with the physical world. Robot also can be use for moving purpose if equipped with proper electronic components.

There are many mechanism and controllers that can control a robot and other remote controlled devices. Mobile phones rapidly breaking the traditional barriers that come in the way of human-machine interaction. Mobile phones in the recent times have become efficient devices, which can be use for controlling. It is a result of a huge advancement in mobile phones technology. So mobile phone can be used as an controlling device with proper application.

Bluetooth [1] is popular method of communication between devices. Many smart phones today, have the capability to communicate using Bluetooth. The communication of mobile robot and mobile phone can be via Bluetooth.

In this paper have developed control for the mobile robot in which we have used Bluetooth communication. According to commands received from mobile phone, the movement of the mobile robot is controlled.

Mobile phone can be use as a remote control for the mobile robot. Bluetooth for connection between mobile robot and mobile phone. Microcontroller [2] will act as the brain of the mobile robot and DC motor [3] will help us to move the robot.

2. SYSTEM DESIGN

For controlling, the mobile robot for the application can be used Android or Windows mobile phone with Bluetooth and Arduino Uno is use as the microcontroller. The key components of this system are:

- Mobile phone Android or Windows
- Bluetooth module
- Arduino Uno
- H-Bridge L293D
- Two DC Motors

The communication between the mobile phone and the Arduino Uno is via Bluetooth. Figure 1, shows the block diagram of the system architecture.

The application is written in Java using Eclipse as a tool to develop an application on Android mobile phone to connect to Bluetooth [1] and the application for Windows is written in Visual Studio. The concept of our project presented in Figure 1.

Firstly, the user must connect from the application with Bluetooth Module. By clicking on direction buttons corresponding to four directions forward, backward, left, right and one to stop we get the command for move the mobile robot in desired direction.

Secondly, the command will be send from a mobile phone via Bluetooth [1] to Arduino Uno microcontroller board [2]. Thirdly, the microcontroller sends a command to H-Bridge L293D [4] to control the motors.



Figure 1: Block-diagram for control the mobile robot

3. HARDWARE ARCHITECTURE

In this part of the paper, we are going to discuss about the parts and design of the mobile robot [6].

The hardware of the system is consist of following parts:

- Bluetooth Module HC-06
- Arduino Uno
- H-Bridge L293D
- DC motors
- Jumper Wire
- Breadboard

Bluetooth Module it's a device that can connect to microcontroller by Tx-Rx pin and to other devices over Bluetooth. Bluetooth module used in this circuit is the type of HC-06, which requires 3.3V to 5V DC power drawn from the Arduino microcontroller circuit (pin 3.3 V), Pin (TX 1) is to send data on the Bluetooth module HC-06 with microcontroller and Pin (Rx 0) is to receive data on the HC-06 Bluetooth module with microcontroller. The GND (Ground) is a path connecting the data between HC-06 Bluetooth module with microcontroller circuit. The Bluetooth module will act as an interface between Smartphone and microcontroller. Generally, our master will be smartphone and slave will be Bluetooth module. Bluetooth module will give the commands given by smartphone to the microcontroller.

The microcontroller will decide the robot movement. In this system we use microcontroller named Arduino Uno which contains Atmega 328p microcontroller chip. It has 14 digital input/output pins. Arduino microcontroller serves as the brain of the whole system. Arduino has it own programming environment through which the microcontroller can be programed.

Because our system is for controlling purpose, we using two DC motors [3]. A H-Bridge L293D [4] is used to control the DC motor.

The L293D is designed to provide bidirectional drive currents of up to 600-MA at voltages from 4.5V to 36V. L293D is a typical Motor driver which is used to drive direct current on either direction. It is a 16-pin IC which can control

a set of two DC motors simultaneously in any direction. It means we can control two DC motor with a single L293D. The L293D can drive small and quiet big motors.

Jumper wires used to interconnect the components in a breadboard [5]. They are used to transfer electrical signals from anywhere on the breadboard to the input/output pins of a microcontroller.

We used breadboard to mount the electrical component. All of the above mentioned components will be mounted on the breadboard.

In this system we use batterys to supply power to the electronic components of the system. Mainly the microcontroller and DC motor need power supply. The hardware system is given on Figure 2.

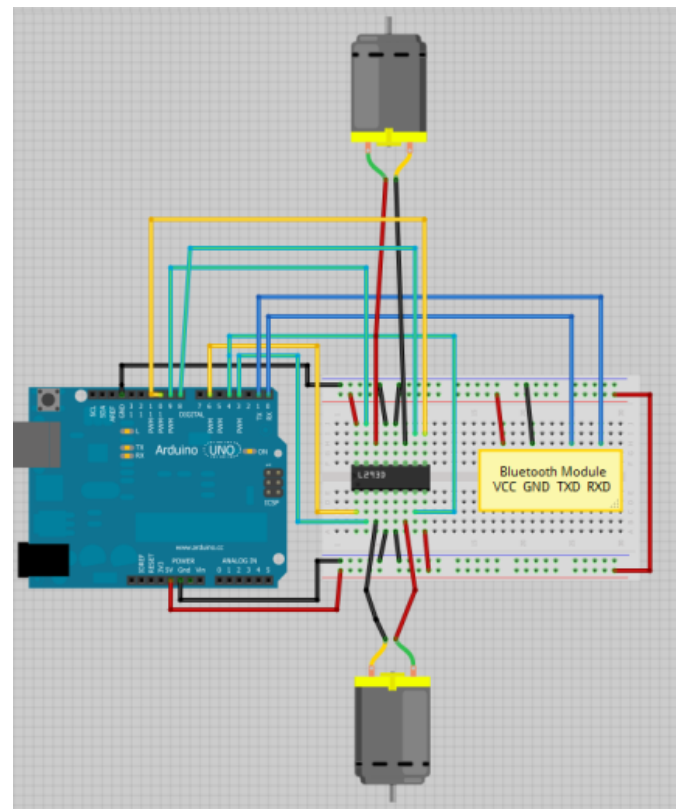


Figure 2: Diagram of the hardware system

4. SOFTWARE DEVELOPMENT

For the software solution, we have made to control the mobile robot from two different platforms for Windows and for Android mobile phone.

Windows Phone is a family of mobile operating systems developed by Microsoft. It is the successor of the Windows Mobile platform. Windows Mobile division and started to work on a new mobile operating system that would offer better user experience and usability for new consumer. Despite the fact Windows phone is the youngest mobile platform, it provides excellent development environment within the SDK. Visual Studio is maybe the best IDE currently available.

Android platform is powerful mobile computer and they become more and more popular smart phones. They become more and more popular for software developers because of its powerful capabilities and open architecture. It is based on Java programming language. Because Android uses Java programming language getting started with the Android API is easy, the API is open and allows easy access to the hardware components. Android device provides numerous communication interfaces like Wi-Fi, Bluetooth that can be used to connect to the robot. It is a great platform for robotics system control, because it is much cheaper than any other. We have chosen Android platform because it is the widest used platform in the world and runs the largest number of mobile phones.

Android has become the top mobile gadget operating system (OS) on the market today. In other words, the Android phone has become the most popular and commonly used OS in society.

Android had unique support for Bluetooth in Android-powered devices including: Classic Bluetooth for more battery-intensive operations such as streaming and communicating and with low power requirements, Android 4.3 introduces API support for Bluetooth Low Energy.

The Windows application for control can use on mobile phone or PC/laptop by using mouse or touch pad. This method provides facility to the user to control the mobile robot. The other control method is for Android mobile phone or tablet. After installing the application, the user can easily touch on the screen of the phone to control the mobile robot. Is easy using any Android mobile phone and Windows mobile phone or PC that has Bluetooth.

In the Figure 3, is display the interface of Android application [7][8]. The both applications have the same interface for control the mobile robot with buttons.

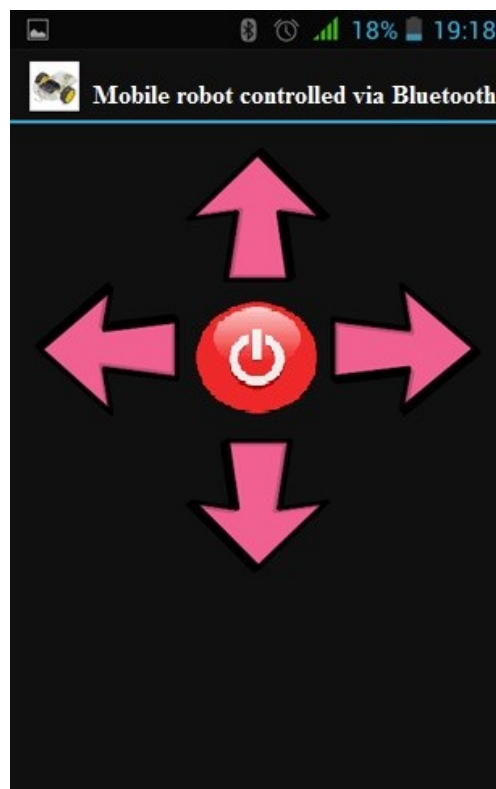


Figure 3: Interface of application

The block diagram in Figure 4, describes the entire system. After start the application on the mobile phone. Upon the execution of the program, it first checks if Bluetooth is already enabled on the phone. If Bluetooth is enabled, the device and service discovery process will run. The software will check if there are already predefined devices stored in the phone memory. If they do exist, they will be list down for the user to select one. The program then checks to see if the selected device is in range. Now if there are no devices stored in memory, the program will search for Bluetooth-enabled devices within the area. Once discovered, these devices will be displayed on the screen and also stored in memory.

After choosing the wanted device mobile phone start the connection. If is not connected the application display error message Device disconnected. If is connected is display the interface for control. If we press on button to control the mobile robot the application get the command from the button and via Bluetooth, command is transmit to Arduino Uno. H-Bridge L293D it connected with motors. It takes signal from microcontroller. DC motor works on dc signal received from the motor driver H-Bridge L293D. Mobile robot it's move to the wanted direction.

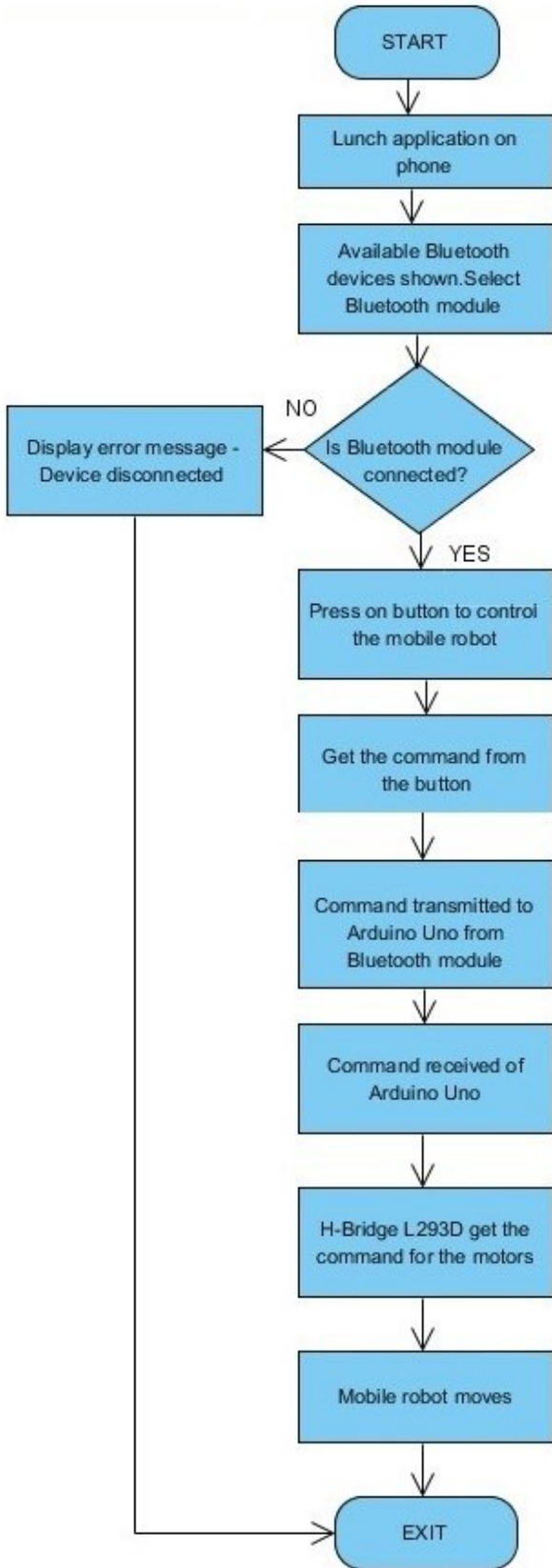


Figure 4: Diagram of the entire system

5. CONCLUSION

This paper is to realize the smart living, more specifically the mobile robot control system using Bluetooth Technology. Robot and mobile phones are the perfect match, specially mobile robots. The proposed system shows how the android and windows mobile phone we used as remote controller for mobile robot. The operating system is for Android and Windows phones. The communication between mobile phone and mobile robot is via Bluetooth. Bluetooth communication makes it simple and quick to control mobile robot. The movements of the mobile robot are tested. By clicking on direction buttons corresponding to four directions, mobile robot moves rapidly. Interface of applications consists of five buttons. Four buttons designed for all directions forward, backward, left, right and one to stop mobile robot.

In the future could improve control of the mobile robot by connecting the camera Kinect xbox 360 via Bluetooth. Kinect serves to recognize movements. So could by recognizing the movement of hands to control the mobile robot. Also can be added voice recognition to control the mobile robot by speaking directly.

REFERENCES

- [1] Inigo Puy, "Bluetooth", Hochschule Furtwangen University, 2008
- [2] David R, "Arduino-Based Dataloggers: Hardware and Software", Institute for Earth Science Research and Education, 2015
- [3] Rick Bickle, "DC motor control systems for robot applications", 2003
- [4] Vincent Sieben, "A High Power H-Bridge", 2003
- [5] Terry Sturtevant, "Electronics Breadboards", Wilfrid Laurier University, 2012
- [6] Anil Khurana, "Bluetooth Based Robotic Car", Asian International Conference on Science, Engineering & Technology, 2015
- [7] Devesha Parmar, Devashish Tripathi, Agam Sahni, Pankaj Singh, "Bluetooth Operated Robot Vehicle Using Mobile Android App", International Journal of Research in Engineering & Advanced Technology, 2015
- [8] Mrumal.K.Pathak, Javed Khan, Aarushi Koul, Reshma Kalane, Raunak Varshney, "Robot Control Design Using Android Smartphone", Information Technology, Savitribai Phule Pune University, 2015