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POJEDNOSTAVLJENA ELEKTROMAGNETSKO-TOPLINSKA ANALIZA IZLOŽENOSTI LJUDI ZRAČENJU ANTENA BAZNIH STANICA

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U ovom radu izložena je elektromagnetsko-toplinska analiza ljudskog tijela izloženog zračenju antena baznih stanica. Formulacija problema zasniva se na cilindričnom modelu ljudskog tijela. Elektromagnetski dio analize uključuje dozimetriju upadnog i unutarnjeg polja, dok se toplinskim modelom opisuje prijenos topline u tijelu. Električno polje inducirano u tijelu određuje se preko struje inducirane u tijelu. Raspodjela struje uzduž tijela dobivena je rješavanjem Pocklingtonove integralne jednadžbe za »debeli« cilindar. Pocklingtonova integralna jednadžba numerički je riješena primjenom Galerkin-Bubnove metode rubnih elemenata. Jednom kada je dobiveno unutarnje električno polje i ukupna snaga apsorbirana u tijelu, moguće je izračunati odgovarajući porast temperature u tijelu zbog izloženosti GSM zračenju. Ovaj porast temperature određuje se rješavanjem bio-toplinske jednadžbe primjenom metode konačnih elemenata.

(Sl. 5, Tab. 3, Lit. 11 – original na engleskom) *Autori*

antene baznih stanica
cilindrični model tijela
elektromagnetsko-toplinska analiza
izloženost ljudi zračenju

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STABILNOST MIKROVALNIH I ELEKTRONIČKIH AKTIVNIH ELEMENATA: ANALIZA PRIMJENOM TEOTIJE DINAMIČKIH SUSTAVA

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Razmotren je općeniti problem stabilnosti mikrovalnih i radiofrekvencijskih aktivnih elemenata i sklopova u prisustvu višefrekvencijskih ili širokopojasnih signala. Problem je formuliran kao sustav nelinearnih neautonomnih diferencijalnih jednadžbi u poopćenim koordinatama faznog prostora koje se mogu pridružiti npr. amplitudama električnih struja u sklopovima od elemenata s koncentriranim parametrima ili amplitudama modova elektromagnetskog polja u sustavima s raspodijeljenim parametrima. Predložena je analiza stabilnosti koja omogućava predviđanje različitih vrsta nestabilnosti uključujući deterministično kaotično gibanje. Razmotren je novi kriterij koji se osniva na analizi Ljapunovljevih eksponenata. Taj kriterij uspostavlja vezu između najveće stabilne amplitude oscilacija te razina nelinearnosti i prigušenja u sustavu. Podrobno su analizirani primjeri jednomodnog i dvomodnog oscilatora.

(Sl. 1, Lit. 8 – original na engleskom) *Autor*

kaos
Ljapunovljevi eksponenti
mikrovalni sklopovi
oscilatori
nestabilnost

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ELEKTROMAGNETSKI MODEL TERAHERCNOG MJEŠALA S DVOSTRUKOM PROREZNOM ANTENOM

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Dvostruka prorezna antena u koju su ugrađeni supravodljivi elektronički elementi trenutačno se razvija za terahercna mješala i detekore za primjenu u astronomskim promatranjima. Iako ta mješala imaju nisku temperaturu šuma, redovito se javlja značajan pomak središnje frekvencije na niže vrijednosti u usporebi s rezultatima proračuna dobivenih uobičajenim pojednostavljenim modelima. Ovo je odstupanje frekvencije posljedica više uzroka. Najnovija su istraživanja pokazala da su najvažniji uzroci ovog odstupanja prijelaz između bolometra i koplanarne prijenosne linije, filtar za potiskivanje radiofrekvencijskog signala i gubici zbog zračenja koplanarne linije. U ovom se radu razmatraju ovi uzroci te novi elementi, kao što je silicijska leća, da bi se dobio robustniji model pogodan ne samo za analizu već i za sintezu ovih sklopova. Koristeći ovaj model izrađeno je i ispitano više terahercnih mješala na četiri različite središnje frekvencije između 600 GHz i 2,5 THz. Preliminarni rezulati prijenosa snage na 2,5 THz još uvijek nisu u potpunosti zadovoljavajući, ali pokazuju da je predloženi model postavio dobre smjernice. U usporedbi s ranijim izvedbama, nova mješala imaju mnogo bolju djelotvornost prijenosa snage u supravodljive elektroničke elemente, a pomak središnje frekvencije se smanjio s 30 % na 10 %.

(Sl. 4, Lit. 5 – original na engleskom) *Autori*

koplanarni valovod
bolometar
prorezna antena
terahercne frekvencije

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DOMINANTNI MOD GUSTOĆE STRUJE NA SPIRALNOJ PATCH ANTENI

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U radu je prikazan privlačan i djelotvoran pristup proračunu i analitičkom prikazu spiralnih patch antena. Prvo je izveden aproksimativni analitički izraz za dominantni mod gustoće struje na spiralnom patchu. Pomoću izvedenog izraza moguće je jednostavno izračunati dijagrame zračenja patch antene. Proračunom je potvrđeno da se dijagrami zračenja ovakve log-periodičke antene ne mijenjaju s frekvencijom. Utvrđeno je dobro podudaranje proračuna dijagrama zračenja s rezultatima mjerenja. Predloženo je proširenje za više modove gustoće struje pogodne za analizu patch antene pomoću metode momenata. Primjenom metode momenata uz predloženo proširenje višim modovima može se s većom točnošću proučavati i druge osobine antene kao npr. dobitak i ulazna impedancija.

(Sl. 5, Lit. 7 – original na engleskom) *Autori*

spiralna antena
širokopojasna planarna antena
menadrirajuća spiralna antena

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STABILITY OF MICROWAVE AND ELECTRONIC DEVICES: AN APPROACH FROM DYNAMICAL SYSTEMS THEORY

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The general problem of stability of microwave and RF devices and circuits in the presence of multi-frequency or broadband signals is addressed. The problem is formulated in terms of the system of nonlinear non-autonomous differential equations for generalized coordinates in the phase space that can be attributed to, e.g., amplitudes of electric currents in circuits with lumped elements or mode amplitudes of the electromagnetic field in the distributed systems. An approach to the stability analysis is proposed that allows predicting the appearance of various kinds of instabilities including the deterministically chaotic motion. The new criterion based on the analysis of Lyapunov exponents is discussed that establishes the relation between maximal stable amplitude of oscillations and the levels of nonlinearity and damping in the system. The examples of one- and two-mode oscillators have been considered in detail.

(Fig. 1, Ref. 8 – original in english) *Author*

chaos
Lyapunov exponents
microwave circuits
oscillators
instability

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A SIMPLIFIED ELECTROMAGNETIC-THERMAL ANALYSIS OF HUMAN EXPOSURE TO RADIATION FROM BASE STATION ANTENNAS

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Electromagnetic-thermal analysis of the human body exposed to base station antennas radiation is presented in this paper. The formulation of the problem is based on a simplified cylindrical representation of the human body. Electromagnetic part of the analysis involves incident and internal field dosimetry, while the thermal model deals with the bio-heat transfer processes in the body. The electric field induced in the body is determined through the corresponding axial current induced in the body. This current distribution along the body is obtained by solving the Pocklington integral equation for a thick cylinder. The Pocklington integral equation is solved numerically via the Galerkin-Bubnov Boundary Element Method (GB-BEM). Once the internal electric field and related total absorbed power in the human body is obtained, it is possible to calculate a corresponding temperature rise in the body due to the GSM exposure. This temperature rise is determined by solving the bio-heat transfer equation via the conventional finite element method (FEM).

(Fig. 5, Tab. 3, Ref. 11 – original in english) *Authors*

base station antennas
cylindrical body model
electromagnetic-thermal analysis
human exposure

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AUTOMATIKA 45(1–2),29–32(2004)

CURRENT DENSITY DOMINANT MODE ON SPIRAL PATCH ANTENNAS

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An elegant and efficient way to calculate and analytically show the main features of spiral patch antennas is presented in this paper. The derivation of an approximate analytical expression for the dominant current density mode on the patch is initially presented, from which it can be easily calculated the patch radiation pattern. Its invariance with frequency scaling, which is the main feature of such log-periodic antennas, is in particular shown, together with a good congruency with experimental results. An extension to higher-order modes for a MoM analysis of the current density is then suggested, which may be useful to study with higher accuracy the other antenna characteristics, such as gain and input impedance at the feed.

(Fig. 5, Ref. 7 – original in english) *Authors*

spiral antenna
broadband planar antennas
sinuous antenna

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ELECTROMAGNETIC MODEL FOR TWIN SLOT TERAHERTZ MIXERS

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Twin slot antennas coupled to superconducting devices are currently being developed for terahertz mixers and direct detectors for astronomical observations. Although these mixers show promising performance in terms of noise temperature, they usually also show a considerable downward shift in the center frequency, especially when compared with calculations obtained with commonly used simplified models. This discrepancy is actually due to a variety of reasons. The effect of the bolometer-to-CPW transition, the RF choke filter and the radiation losses in the CPW line have been demonstrated in a recent study to be some of the most important reasons of the disagreement between calculations and measurements. In this paper we discuss these effects and other features, such as the silicon lens, obtaining a more robust model suitable not only for analysis but also for the synthesis of these circuits. A complete set of terahertz mixers at four different center frequencies, between 600 GHz and 2.5 THz, has been fabricated following the guidelines provided by our model and is currently being tested. The preliminary results of power coupling measured at 2.5 THz are still not as good as expected, however they show that our model is going in the right direction. With respect to previous designs, the new mixers have now a much better efficiency in terms of power coupling to the superconducting device and the center frequency shift is now decreased roughly from 30 % to 10 %.

(Fig. 4, Ref. 5 – original in english) *Authors*

coplanar wave-guide
hot electron bolometer
slot antennas
terahertz frequency

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JEDNO I VIŠE ELEMENTNE MIKROTRAKASTE MONOPOLNE ANTENE MINKOWSKOG ZA POKRETNE KOMUNIKACIJSKE UREĐAJE

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U radu je prikazana fraktalna monopolna antena Minkowskog. Ova je antena namijenjena pokretnim komunikacijskim uređajima s jednom ili više antena. U slučaju primjene jedne antene proučen je utjecaj njezinog položaja u odnosu na osnovnu vodljivu ravninu i predložen je postupak za fino ugađanje sustava u uvjetima najgoreg slučaja. Istražen je i utjecaj izmjera osnovne vodljive ravnine na ulaznu impedanciju antene i na njezine dijagrame zračenja te su izvedeni općeniti zaključci. Zatim je istražen i antenski niz od četiri takva elementa. Proučavane su karakteristike niza kada se niz koristi u uvjetima diverzitija. Karakteristike diverzitija vrednovane su pomoću korelacijskog koeficijenta anvelope, srednjeg efektivnog dobitka i efektivnog dobitka diverzitija. Razmotren je i utjecaj međusobne sprege antena na ukupne karakteristike antenskog sustava.

(Sl. 11, Tab. 2, Lit. 15 – original na engleskom) *Autori*

antenski diverziti
dobitak diverzitija
fraktalna antena
utjecaj osnovne vodljive ravnine
Minkowski
monopolna antena

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SIMULACIJA PRIJENOSA DIGITALNE SLIKE UPORABOM DVB KODOVA ZA UNAPRIJEDNO ISPRAVLJANJE POGREŠKE

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Doprinos rada je u simulaciji prijenosa digitalnog videosignala putem modela kanala za prijenos u osnovnom pojasu. Prikazan je simulacijski model koji uključuje odabrane postupke obrade signala u sustavu za radiodifuziju digitalnog videosignala (DVB, Digital Video Broadcasting). Digitalni videosignal je predstavljen u obliku digitalnih podataka jedne nekomprimirane slike, koja je kanalno kodirana i zaštićena od pogrešaka uporabom kodova za unaprijedno ispravljanje pogreške (FEC, Forward Error Correction). Model prijenosnog kanala ima utjecaj na prijenos digitalnih podataka, tako da izobličenje i smetajući signali u kanalu djeluju na dekodiranje podataka. Također su opisane značajke razvijene interaktivne programske podrške za simulaciju (Matlab aplikacija) i zaključci koji prikazuju djelotvornost korištenih FEC kodova.

(Sl. 5, Tab. 2, Lit. 6 – original na engleskom) *Autor*

digitalna slika
izvorno i kanalno kodiranje
model prijenosnog kanala

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Prethodno priopćenje

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KOMPAKTNI MOTORI I POGONI ZA ELEKTRIČNA VOZILA

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S obzirom na veliku korisnost, beskolektorski motori s permanentnim magnetima na rotoru nalaze značajnu primjenu u električnim vozilima. U članku su opisani eksperimentalni rezultati razvoja beskolektorskih elektronički komutiranih motora integrirane izvedbe. Koriste se elektronički komutirani motori s pravokutnom strujom i trapezoidalnom idukcijom u zračnom rasporu kao i motori sa sinusoidalnom strujom i indukcijom, upravljani iz digitalnog signalnog procesora, (DSP). Razvijen je upravljački sustav s inverterom i motorom kao i upravljačka programska podrška. Analizirani su i simulacijski provjereni suvremeni algoritmi upravljanja te njihova primjenjivost na bilo koji tip navedenih motora.

(Sl. 15, Tab. 2, Lit. 10 – original na engleskom) *Autori*

električna vozila, beskolektorski pogoni, primjena u automobilskoj industriji
adaptivno upravljanje, digitalni signalni procesor (DSP), vektorsko upravljanje
neuronske mreže, klizni režim rada, simulacija

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PARALELNI AKTIVNI ENERGETSKI FILTAR S PREDIKTIVNIM ODREĐIVANJEM REFERENTNE STRUJE – EKSPERIMENTALNI SUSTAV

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U svrhu eksperimentalne provjere rezultata simulacije trofaznog aktivnog filtra s prediktivnim određivanjem referentne struje izrađena je njegova laboratorijska maketa. U radu je prikazan funkcionalan opis laboratorijske makete trofaznog aktivnog filtra. Energetski krug aktivnog filtra sastoji se od tri jednofazne prigušnice, trofaznog izmjenjivača s IGBT-ovima i dva simetrična kondenzatora na istosmjernoj strani. Regulacija struje realizirana je pomoću tri neovisna histerezna regulatora. Razrađen je algoritam filtarskog sustava s prediktivnom strukturom za određivanje referentne struje i implementiran na DSP. Prikazani su eksperimentalni rezultati ostvarenog trofaznog aktivnog filtra u stacionarnom i dinamičkom režimu rada. Dobiveni eksperimentalni rezultati potvrđuju učinkovitost aktivnog energetskog filtra pri slabljenju viših harmonika struje u mreži.

(Sl. 17 + 4, Lit. 18 – original na hrvatskom) *Autori*

aktivni energetski filtar
DSP
harmonici
histerezni regulator
IGBT
prediktivni filtar

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DIGITAL IMAGE TRANSMISSION SIMULATION USING THE DVB FORWARD ERROR CORRECTION CODES

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The contribution deals with the simulation of the digital video signal transmission through the base-band transmission channel model. The simulation model that covers selected phenomena of DVB (Digital Video Broadcasting) system signal processing is presented. The digital video signal is represented with the digital data of one non-compressed video frame that is channel encoded and protected against errors with the forward error correction (FEC) codes. The transmission channel model has influence on transmitted digital data and its distortion and the pertubative signals affect on the data decoding. The developed interactive simulation software (Matlab application) features are outlined too and the conclusion presents efficiency of the used FEC codes.

(Fig. 5, Tab. 2, Ref. 6 – original in english) *Author*

digital image
source and channel encoding
transmission channel model

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SINGLE AND MULTI ELEMENT PRINTED MINKOWSKI MONOPOLE ANTENNAS FOR PORTABLE TERMINAL DEVICES

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In this paper a printed fractal Minkowski monopole is presented for use in wireless terminal devices utilizing single and multi element antenna systems. In the case of a single element system the effect of the antenna's placement with respect to the ground plane is examined and a method to fine tune the system in its worst case situation is proposed. The influence of the ground plane dimensions on the system's impedance and radiation characteristics is also investigated and general conclusions are drawn. Subsequently, a four element antenna system for diversity applications is investigated. The diversity performance is evaluated by means of the envelope correlation coefficient, the mean effective gain and the effective diversity gain. The impact of the mutual coupling on the system's performance is also addressed.

(Fig. 11, Tab. 2, Ref. 15 – original in english) *Authors*

antenna diversity
diversity gain
fractal antenna
ground plane effect
Minkowski
monopole antenna

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PARALLEL ACTIVE POWER FILTER WITH PREDICTIVE STRUCTURE FOR REFERENCE CURRENT DETERMINATION – EXPERIMENTAL SYSTEM

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For the purpose of simulation results testing, a laboratory prototype of three-phase active power filter with predictive structure for reference current determination has been developed. A functional description of the laboratory prototype is presented. Power stage of the proposed active filter has been realized using three serial inductance, three-phase IGBT based current control voltage inverter with two symmetrical capacitors on dc bus. Three independent hysteresis controllers on the base of reference currents were used to generate switching signals for inverter transistors. The algorithm for current reference determination as a combination of digital predictive filter and low pass filter was developed and implemented on DSP controller. The experimental results of three-phase active power filter for stationary and dynamic regimes are presented. Experimental results show that the active power filter gives satisfactory performance in power system harmonic attenuation.

(Fig. 17 + 4, Ref. 18 – original in croatian) *Authors*

active power filter
DSP
harmonic
hysteresis controller
IGBT
predictive filter

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COMPACT MOTORS AND DRIVES FOR ELECTRIC VEHICLES

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Due to their high efficiency, brushless PM rotor motors are very suitable for vehicle drive application. This paper presents experimental results of a newly developed technique in brushless motors. It is suitable for both square current and DSP-controlled sinusoidal current drives. The experimental result of such systems is described. The drive systems, including the inverter, the motor and the controlling software, have been developed by the authors. Also, popular controlling algorithms have been used, and a common way to initialise them in order to enable to operate with any kind of motors.

(Fig. 15, Tab. 2, Ref. 10 – original in english) *Authors*

electric vehicles, brushless drives, automotive application
adaptive control, DSP, vector control, neural networks
sliding mode control, simulation

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MEĐUDJELOVANJE POJNOG USMJERIVAČA ISTOSMJERNOG MEĐUKRUGA NAPAJANIH IZMJENJIVAČA S IZRAZITO REGENERATIVNIM TERETOM

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U članku je opisano tehničko rješenje grupe izmjeničnih elektromotornih pogona, napajanih iz zajedničkih istosmjernih sabirnica. Osim visokih regulacijskih zahtjeva, opisane pogone karakteriziraju vrlo učestale promjene brzine i momenta, koje zbog rotacijskih masa, zahtijevaju znatnu kočnu snagu. Zahtjevi za postupno nabijanje kondenzatora izmjenjivača, te povrat energije u mrežu tijekom kočenja, u potpunosti opravdavaju primjenu četverokvadrantnog pojnog tiristorskog usmjerivača. Opisane su osnovne značajke sustava, problemi, rješenja i iskustva stečena tijekom puštanja u rad, posebno međudjelovanje pojnog usmjerivača i napajanih izmjenjivača tijekom regenerativnog kočenja. Uz korištenje kompenzacijskog djelovanja po struji istosmjernog međukruga, napravljena je usporedba predloženog pseudo-derivacijskog (PDF) regulatora napona istosmjernog međukruga u odnosu na klasični kaskadni PID regulator. Pokazatelji kvalitete sustava regulacije eksperimentalno su potvrđeni u tehnološkom procesu valjanja žice $\phi 5$ tijekom regenerativnog kočenja, pri brzini valjanja od 100 m/s.
(Sl. 12, Tab. 2, Lit. 10 – original na engleskom) *Autori*

tiristorski pojni usmjerivač
istosmjerni međukrug
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izmjenični pogoni
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INTERACTION OF DC-LINK SUPPLY UNIT AND SUPPLIED INVERTERS WITH REGENERATIVE LOAD

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A technical solution for the group of AC adjustable speed drives supplied from a common DC link has been described. Besides high control demands, the described drives have very fast speed and torque changes, resulting with significant required braking power due to high load inertia. The demands for progressive converter capacitor charging and braking energy recuperation are suggesting application of four-quadrant SCR (Silicon Controlled Rectifier) line converter for supplying common DC link. Basic system properties, problems, solutions and experience acquired during system commissioning have been analyzed, particularly the interaction of DC link supply converter and connected inverters during regenerative braking. The influence of the additional DC link voltage compensation on the system properties in recuperation mode, together with a comparison between the proposed pseudo-derivative feedback (PDF) voltage controller and the cascade PID controller, has been made. The experimental verification of the dynamic system performance during recuperation has been performed in wire rod rolling mill $\phi 5$, with high technological production line speed of 100 m/s.

(Fig. 12, Tab. 2, Ref. 10 – original in english) *Authors*

SCR line converter, common DC link inverters, AC drives regenerative braking

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