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## PREDIKTIVNO UPRAVLJANJE ELEKTROMOTORNIM POGONOM S ELASTIČNOŠĆU I ZRAČNOŠĆU U PRIJENOSNOM MEHANIZMU ZASNOVANO NA NEIZRAZITOM MODELU PROCESA

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Predložena je strategija upravljanja elektromotornim pogonom s elastičnošću i zračnosću u prijenosnom mehanizmu zasnovana na primjeni poopćenog prediktivnog regulatora (GPC). Neizraziti model prema Takagiju i Sugenu primijenjen je za identifikaciju dvomasenog mehaničkog sustava s elastičnim prijenosnim mehanizmom, zračnošću i zanemarivim trenjem. Pretpostavlja se da je dostupno samo mjerenje na strani tereta. Kako poopćeni prediktivni regulator (GPC) zahtijeva linearni model za proračun optimalnog upravljačkog signala, neizraziti model prema Takagiju i Sugenu linearizira se primjenom trenutačne linearizacije u svakom koraku uzorkovanja. Ova strategija upravljanja uspoređena je potom s klasičnim poopćenim prediktivnim regulatorom zasnovanim na linearnom ARX modelu, simulacijom i eksperimentalno na laboratorijskom modelu elektromotornog pogona s elastičnošću i zračnosću u prijenosnom mehanizmu.

*(Sl. 9, Lit. 9 – original na engleskom)*

*Autori*

*elektromotorni pogon, elestičnost prijenosnog mehanizma, zračnost, modelsko prediktivno upravljanje, Takagi-Sugenov neizraziti model*

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## NELINEARNO UPRAVLJANJE S UNUTARNJIM MODELOM ZA POGON S PREKIDAČKIM RELUKTANTNIM MOTOROM BEZ OSCILACIJA MOMENTA

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Predloženo je i razrađeno novo rješenje za upravljanje sklopnim reluktantnim motorom (SRM) zasnovano na nelinearnom upravljanju s unutarnjim modelom (IMC) i prikladnoj strategiji komutacije. Strategija komutacije koristi definiranu kritičnu poziciju rotora kao točku komutacije što doprinosi smanjenju računskih zahtjevnosti. Shema za upravljanje naponom SRM-a zasnovana na nelinearnom IMC-u osigurava linearizaciju zatvorenog sustava i robusnost IMC strukture što rezultira ukupnom robusnošću pogona bez oscilacija momenta unatoč nepodudaranju modela smetnji sa stvarnim smetnjama. Opisana su neka važna svojstva ovoga načina upravljanja. Simulacijskim se rezultatima pokazuje visoka kvaliteta upravljanja SRM-a.

*(Sl. 11, Lit. 10 – original na engleskom)*

*Autori*

*nelinearno upravljanje s unutarnjim modelom*
*SRM*
*minimizacija oscilacija momenta*

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AUTOMATIKA 43(1–2),21–28(2002)

## PRIMJENA TEORIJE UPRAVLJANJA DISKRETNIM DOGA AJIMA U PROGRAMIRANJU PLC-OVA

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U radu su prikazane realizacije regulatora zasnovanog na teoriji upravljanja diskretnim događajima. Regulatori su realizirani pomoću standardnih programirljivih kontrolera i u skladu s IEC 61131-3 programskom podrškom.

*(Sl. 14, Lit. 11 – original na engleskom)*

*Autori*

*sustavi diskretnih događaja*
*programirljivi kontroleri*
*nadzorno upravljanje*

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## DETEKCIJA I KLASIFIKACIJA KVAROVA NA BESPILOTNOJ RONILICI UPORABOM $T^2$ STATISTIKE

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Detekcija i klasifikacija kvarova kritični su koraci kod primjene upravljanja s promjenjivom strukturom. Članak opisuje Hottelig $T^2$ statistiku koja je primijenjena na detekciju i klasifikaciju zaglavljenja krmenih zakrilaca i kormila kod bespilotnih ronilica. Prikazani su simulacijski rezultati sa i bez šuma mjerenja. Rezultati pokazuju da je predloženi postupak sposoban brzo i pouzdano detektirati i klasificirati ove kvarove.

*(Sl. 7, Lit. 11 – original na engleskom)*

*Autori*

*detekcija kvara*
*klasifikacija kvara*
*upravljanje s promjenjivom strukturom*

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**NONLINEAR INTERNAL-MODEL CONTROL FOR SWITCHED RELUCTANCE DRIVE WITH TORQUE RIPPLE-FREE**

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Based on the nonlinear internal-model control (IMC), associated with the suitable commutation strategy, a novel control solution for switched reluctance motor (SRM) is formulated and designed. The commutation strategy uses a definite critical rotor position as commutation point, which reduces the computational burden. The nonlinear IMC-based voltage control scheme for SRM extracts the simplicity of the feedback linearization control and the robustness of IMC structure, which ensures the torque ripple-free and the drive's robustness in spite of the plant-model mismatch disturbances. Some important properties are presented. Simulation results show that the high-performance control for SRM has been achieved.

*(Fig. 11, Ref. 10 – original in English)*

*Authors*

*nonlinear internal-model control*
*SRM*
*torque-ripple minimization*

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Original scientific paper

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**FUZZY MODEL PREDICTIVE CONTROL OF ELECTRICAL DRIVES WITH TRANSMISSION ELASTICITY AND BACKLASH**

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Control strategy based on generalized predictive controller (GPC) is proposed for control of electrical drives with transmission elasticity and backlash. Takagi-Sugeno fuzzy model is used for identification of the two-mass mechanical system with elastic transmission and backlash with negligible friction. It is assumed that only measurement at the load side is available. Since GPC controller requires linear process model, Takagi-Sugeno fuzzy model is linearized by means of instantaneous linearization in each sample instant. This control strategy is then compared to the classical GPC based on linear ARX model by computer simulations and experimentally on a laboratory model of the electrical drive with transmission elasticity and backlash.

*(Fig. 9, Ref. 9 – original in English)*

*Authors*

*electrical drive, transmission elasticity, backlash, model predictive control, Takagi-Sugeno fuzzy model convex optimization*

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Preliminary communication

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**FAULT DETECTION AND CLASSIFICATION IN UNDERWATER VEHICLES USING THE $T^2$ STATISTICS**

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Failure detection and classification are crucial steps in the implementation of reconfigurable control. This paper describes the application of the Hotelling $T^2$ statistics to the detection and classification of stern plane and rudder jams in underwater vehicles. Simulation results with and without measurement noise are presented. Results indicate that this method is capable of providing rapid and reliable detection and classification of these faults.

*(Fig. 7, Ref. 11 – original in English)*

*Authors*

*failure detection*
*failure classification*
*reconfigurable control*

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Professional paper

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**DISCRETE EVENT CONTROL THEORY APPLIED TO PLC PROGRAMMING**

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*E-mail: gasper.music@fe.uni-lj.si, drago.matko@fe.uni-lj.si.*

In the paper we present an implementation method for controllers designed by discrete event control theory. Controllers are implemented by standard programmable logic controller and IEC 61131-3 compliant programming software.

*(Fig. 14, Ref. 11 – original in English)*

*Authors*

*discrete event systems*
*programmable controllers*
*supervisory control*

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## HEURISTIČKI POSTUPCI IZDVAJANJA ZNAČAJKI U OBRADI SIGNALA

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Izdvajanje relevantnih značajki je ključan korak u sustavu za raspoznavanje uzoraka i klasifikaciju. Cilj postupka izdvajanja značajki je pronalaženje najmanjeg skupa značajki koji sadrži informacije potrebne za raspoznavanje uzorka. Predloženi postupak temeljen je na pretpostavci da će značajke koje pojedinačno bolje razlikuju uzorke iz različitih klasa to svojstvo imati i u kombinaciji s drugim značajkama. Nakon izdvajanja iz početnog skupa, značajke se sortiraju po padajućoj vrijednosti kriterijske funkcije. Iz sortiranog skupa značajki formira se stablo pretraživanja, tako da će skupovi koji sadrže pojedinačno bolje značajke biti pretraženi prije. Predložena su dva postupka izdvajanja značajki: prvi provodi pretraživanje stabla po dubini ograničeno zadanim porastom vrijednosti kriterijske funkcije, a drugi je temeljen na genetskom algoritmu. Postupci su prema kvaliteti izdvojenih skupova značajki i efikasnosti uspoređeni s postupkom potpunog pretraživanja i slijednim postupcima (FSS, BSS).

*(Sl. 16, Lit. 12 – original na engleskom)*

*Autori*

*analiza signala*
*izdvajanje značajki*
*raspoznavanje uzoraka*

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## REKOMBINACIJSKI PROCESI I VREMENA ŽIVOTA ŠUPLJINA I ELEKTRONA

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Poluvodičima s indirektnim zabranjenim pojasom, kakav je silicij, dodaju se duboke primjese s ciljem da bi se postiglo određeno vrijeme života elektrona i šupljina. U članku je razmatrano vrijeme života uzimajući u obzir dva osnovna tipa rekombinacijskih procesa, Shockley-Read-Hallov i Augerov. Pri proračunu je kao duboka primjesa uzeto zlato, koje u silicij unosi dvije duboke energetske razine. Računski je pokazano, a i eksperimentom potvrđeno, da je u većini slučajeva za rekombinacijski proces bitna samo jedna duboka razina i to ona koja je bliža Fermijevoj razini poluvodiča. Iznimka je rad poluvodiča pri visokoj injekciji kada se rekombinacija obavlja preko obje razine. Eksperimentom je potvrđeno da koeficijenti zarobljavanja ovise o temperaturi, te da oba rekombinacijska procesa, Shockley-Read-Hallov i Augerov, treba uzeti u obzir pri proračunu vremena života. Pri proračunima je korišten vlastiti program, kojim je moguće, osim proračuna vremena života uzeti u obzir i ostale efekte koje duboka primjesa ima na električka svojstva poluvodiča, kao npr. utjecaj na vodljivost poluvodiča, na širinu i na kapacitivnost osiromašenog sloja.

*(Sl. 5, Lit. 13 – original na engleskom)*

*Autor*

*rekombinacija*
*duboka primjesa*
*vrijeme života*

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AUTOMATIKA 43(1–2),55–61(2002)

## NOVI REZULTATI U PROJEKTIRANJU I MJERENJU ANTENA ZA OSOBNE POKRETNE KOMUNIKACIJE

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Pokretne komunikacije postaju sve važnije u svakodnevnom životu, a time se povećava potreba za što manjim i lakšim pokretnim komunikacijskim uređajima. Za razliku od elektroničkih sklopova, veličina antene nije određena stupnjem tehnološkog razvoja već je zadana frekvencijskim područjem koje se koristi za određenu primjenu. Zato je minijaturizacija antena umjetnost kompromisa između malih izmjera i dobrih osobina zračenja.
U ovom su radu ograničenja minijaturizacije antena prikazana kroz povezanost dobitaka, širine pojasa i izmjera antene. Zatim su opisani neki uobičajeni postupci za smanjivanje izmjera antena. Njihova je primjena prikazana na praktičnoj izvedbi koja je projektirana i izrađena u našem laboratoriju. Konačno se razmatraju problemi pri mjerenjima malih antena: izneseni su problemi koji su uočeni pri mjerenju malih antena kao i naputci za njihovo prevladavanje.

*(Sl. 9, Lit. 30 – original na engleskom)*

*Autori*

*pokretne komunikacije*
*električki mala antena*
*antenska mjerenja*

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AUTOMATIKA 43(1–2),63–68(2002)

## MJERENJE ANTENA POKRETNIH TELEFONA U MALIM JEČNIM KOMORAMA

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*Representing also Bluetest AB, www.bluetest.se*

Rad prikazuje rezultate istraživanja provedenih na Chalmers University of Technology o mjerenjima antena za pokretne telefone u malim ječnim komorama. Ječne su komore razvijene ponajprije za mjerenja na području elektromagnetske kompatibilnosti. Pokazali smo da se ječne komore mogu koristiti i za mjerenje osobina antena koje su predviđene za rad u uvjetima višestaznog rasprostiranja kao i za mjerenja osobina cjelokupnih pokretnih telefonskih uređaja. Antene i telefoni mogu se ispitivati sa ili bez prisutnosti fantoma ljudske glave ili drugih objekata. Mjerenjem se za antene može odrediti djelotvornost zračenja i koeficijent refleksije za različite položaje antena u odnosu na vanjske objekte kao što je npr. fantom ljudske glave. Rezultati mjerenja su jednaki kao u slučaju kad se antena i fantom nalaze u slobodnom prostoru. Mjerenjima na cjelokupnom pokretnom telefonu određuje se ukupna zračena snaga, koju nazivamo komunikacijska snaga telefona. Ova se snaga također određuje za različite položaje telefona u odnosu na vanjske objekte. U radu su prikazani rezultati mjerenja na antenama i telefonima.

*(Sl. 5, Lit. 14 – original na engleskom)*

*Autor*

*pokretni telefon*
*antena*
*ječna komora*

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## REKOMBINATION PROCESSES AND HOLES AND ELECTRONS LIFETIMES

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In the semiconductor with indirect band gap, such as silicon, recombination on a deep center determines the lifetime of electrons and holes. In this article lifetime is calculated in dependence of both recombination processes, Shockley-Read Hall and Auger. The calculations of lifetime are made for gold in silicon, taking into account both deep levels and neglecting one of them. It is found that in the most cases gold, although having two deep levels, will act as a single level deep impurity. Exceptions are high injection levels where both deep energy levels have influence on recombination process. According to the measured values of lifetime it is confirm that the capture coefficients are temperature dependent and that the both recombination processes, Shockley-Read-Hall and Auger have significant influence on a lifetime.

*(Fig. 5, Ref. 13 – original in English)*

*Author*

*recombination*
*deep impurity*
*lifetime*

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## HEURISTIC ALGORITHMS FOR EXTRACTING RELEVANT FEATURES IN SIGNAL ANALYSIS

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Extraction of relevant features is essential stage in a pattern recognition and classification system. Goal of the feature extraction algorithm is to find feature subset where relevant information for recognition is contained in minimal number of features. Proposed algorithms are based on the assumption that features with better individual discrimination ability will also be better in combination with other features. Features are first extracted from the initial set, then sorted according to their individual fitness. Sorted set is used to form the search tree. Two heuristic algorithms are proposed: the first one performs the depth first search, bounded with required increase of fitness function and the second one is based on genetic algorithm. Their performances are compared with complete search and sequential search (FSS, BSS) algorithms.

*(Fig. 16, Ref. 12 – original in English)*

*Authors*

*feature extraction*
*pattern recognition*
*signal analysis*

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## MEASUREMENTS OF MOBILE PHONE ANTENNAS IN SMALL REVERBERATION CHAMBERS

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The paper gives a summary of the work that have been performed in the Antenna group at Chalmers University of Technology on measuring antennas for mobile phones in reverberation chambers. Reverberation chambers were originally developed for EMC measurements. We have shown that it also can be used to measure performance of antennas that are designed for use in multipath propagation environment, as well as the performance of complete phones. The antennas and phones can be measured with or without the presence of a head phantom or other objects. The antenna measurements give both radiation efficiency and reflection coefficient at different positions relative to an object such as a head phantom, as they would appear if the antenna and the head phantom were located in free space. The phone measurements give the total radiated power, which we refer to as the telephone communication power (TCP), also at different positions relative to an object. The present summary includes results from both antenna and phone measurements.

*(Fig. 5, Ref. 14 – original in English)*

*Author*

*mobile phone*
*antenna*
*reverberation chamber*

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## RECENT ADVANCES IN PCS ANTENNA DESIGN AND MEASUREMENT

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*CH-1015 Lausanne, Switzerland*

Mobile communications are taking more and more importance in everyday life, creating the need for smaller and lighter mobile terminals. Unlike the electronic circuits, the size of an antenna is not technology related, but imposed by the wavelength of a given application. This makes antenna miniaturization to an art of compromise between size and radiation performances.
In this presentations we will first state the limitations of antenna miniaturization, by reminding of the well known laws linking gain, bandwidth and antenna size. Then some well known ways to reduce antennas sizes will be reviewed and illustrated on a practical example designed and realized in our laboratory. Finally, we will deal with the non trivial problem of small antenna measurement: the problems encountered when measuring small antenna will be presented and some clues on how to proceed correctly will be given.

*(Fig. 9, Ref. 30 – original in English)*

*Authors*

*mobile communications*
*electrically small antenna*
*antenna measurement*

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AUTOMATIKA 43(1–2),69–74(2002)

**DIJAGRAM ZRAČENJA SFERNIH I CILINDRIČNIH MIKROTRAKASTIH ANTENA PRAVOKUTNOG OBLIKA**

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U radu je predstavljen program za izračunavanje dijagrama zračenja sfernih i cilindričnih mikrotrakastih antena pravokutnog oblika. Mikrotrakasta antena može biti postavljena unutar ili na površinu općenite višeslojne sferne ili cilindrične strukture. U postupku rješavanja koriste se prednosti transformacije u spektralnu domenu pri čemu je sferna i cilindrična višeslojna struktura rigorozno uzeta u obzir uporabom odgovarajuće Greenove funkcije u spektralnoj domeni. Rezultati pokazuju važnost rigorozne analize zakrivljenih mikrotrakastih antena.

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

*Autori*

*mikrotrakaste antene*
*konformne antene*
*metoda momenata*
*sprega između antenskih elemenata*

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**RADIATION PROPERTIES OF SPHERICAL AND CYLINDRICAL RECTANGULAR MICROSTRIP PATCH ANTENNAS**

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The program for calculating radiation properties of spherical and cylindrical rectangular microstrip patch antenna is presented. The patch can be embedded in or placed on a general multilayer spherical or circular-cylindrical structure. The solution procedure takes advantage of spectral-domain approach and the spherical/cylindrical multilayer structure is rigorously taken into account by calculating appropriate spectral-domain Green's functions. The results show the importance of rigorous analysis of curved patch antennas.

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

*Authors*

*microstrip antennas*
*conformal antennas*
*moment methods*
*antenna array mutual coupling*

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