Registration form (basic details)

1a. Details of applicant
-Name, title(s): **Željko Obrenović, Dr.**
-Male/female: **Male**
-Address for correspondence: **Kruislaan 413, 1098 SJ Amsterdam**

-Preference for correspondence in English: **yes**
-Telephone: **020 592 4202 (office), 06 45 21 3280 (mobile)**
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-Website (optional): **http://www.cwi.nl/~obrenovi/**

-Doctorate (date, dd/mm/yy): **20/10/2004** (thesis defence), **26/04/2005** (promotion)
-Use of extension clause: **no**

1b. Title of research proposal:

A Design Theory for Presenting Heterogeneous Information Under Perceptual Constraints

1c. Summary of research proposal (300 words)

We propose to develop a design theory to aid practitioners in building information presentation systems for a broader set of users and situations. Current approaches, such as those used on the World Wide Web, do not take into account many special needs of the users nor the requirements of situation specific interaction. We aim at extending these approaches to support information presentation suitable not only for a "standard" user in a "standard" environment, but also for disabled users and users who use the system under suboptimal interaction conditions.

Our basic hypothesis is that if we formally describe the presentation context (task, user, devices and environment) in terms of perceptual constraints, we can deduce a form of presentation optimal for that context. We define perceptual constraints as restrictions on information presentation introduced by the user's (dis)abilities, device limitations or the environment conditions. The main innovation of our approach is in using perceptual constraints to obtain a holistic view on different limitations, facilitating (semi-)automatic design of solutions applicable in a larger number of situations.

We plan to develop our design theory in several iterations, incrementally building and correcting it. We will first survey existing work and perform empirical studies to examine the influence of context on information perception. We will formalize observations to develop an ontology-based framework for the description and quantification of perceptual constraints. To validate the theory, we will develop a decision-support system that suggests optimal forms of presentation for a given context based on proposed theory. We will apply our results in the design of prototype applications, and evaluate implemented applications to test and improve the theory. Evaluations will include testing of implementations in different situations with users of different abilities. We will also investigate how our theory can facilitate automatic generation of information presentation.

Key Words: Human information processing; Information interfaces and presentation; Multimodal interaction; Human factors in software design; Multimedia information systems.

1d. NWO Council area:
- **EW:** 'Exacte wetenschappen'   (Physical Sciences / Computer Sciences)

1e. Host institution
- Centrum voor Wiskunde en Informatica (CWI), Amsterdam

2. Description of the proposed research (1800 words)

2a. Research topic

Efficient presentation of information has to take into account many parameters and adapt to the task, user, device and environment. The main issue in designing such information presentation systems is the huge diversity of factors that designers have to take into account. Information is currently available in heterogeneous formats including text, audio, video or 3D scenes. Users access this information through internet-enabled cell phones, PDAs, desktop, laptop and wearable PCs, all of which have very different requirements and presentation capabilities. Devices are used in different contexts, including offices, corridors, homes, streets or transportation. Users are diverse, speaking different languages and possessing different knowledge, age, gender, cultural background and (dis)abilities.

Handcrafting information presentation for all possible tasks, users, devices and situations is simply not manageable: this approach is expensive and time consuming, and often produces several incompatible versions of content [Gurminder04]. If we want to enable a broad range of users to access available heterogeneous information efficiently, through a broad variety of access devices in different contexts, we need to rethink how it is specified and created. Current approaches, such as those used on the World Wide Web, present information optimized for a limited set of users, mainly aimed at desktop computers used in office environments. This isolates not only the disabled users, but also the users who use the system under suboptimal conditions, from a growing number of information sources. The number of people that are excluded from the information society is significant: according to the UN report[1], more than 500 million people have some kind of disability. Most reports, however, suggest that only a small percentage of web sites, which are currently major information presentation systems, are accessible for people with disabilities[2].

This project aims at the development of a novel design theory that supports the design of information presentation systems that take into account user (dis)abilities, and the situations where interaction occurs.

2b. Overall Aim

Our aim is to develop and validate a design theory for information presentation under perceptual constraints. We will pursue an ontology-based approach aimed at providing design recommendations about optimal information presentation for a particular presentation context, in order to aid designers in developing information presentation systems for a more diverse set of users and situations. Our basic hypothesis is that if we formally describe the presentation context in terms of perceptual constraints, we can deduce a form of presentation optimal for that context. We define a perceptual constraint as a restriction on information presentation introduced by a user's (dis)abilities, device limitations or the environmental conditions.

Our goal is to help designers who are often not aware of all the potential problems and constraints that users or new interaction contexts have. Although some existing tools, such as accessibility guidelines [WAI], can help designers to avoid making inaccessible information presentation systems, these guidelines cover a limited range of situations, solving only most acute problems, e.g. providing alternative speech output for blind users [Miline05]. However, many users require support not covered by current guidelines [WAI], there are many other factors that can influence information perception. For example, unattended speech, which is often present in public spaces (e.g. passenger conversation

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[1] http://unstats.un.org/unsd/demographic/sconcerns/disability/
[2] According to the yearly survey from Accessibility.nl, only 4% of the government sites in The Netherlands currently supported basic accessibility level.

in a train, news on the radio), causes information to be removed from short-term memory [Baddeley90]. Information presentation that requires recall of information or usage of short term memory (such as when a user has to keep in mind the structure of the presentation, or switch between two windows), may completely fail in environments where a user listens to or produces speech. Similar problems can be a consequence of user disability: users with short-term memory impairments will have similar problems even when they are not in a noisy environment. *These facts are not obvious and often surprising for developers [Buxton95, Karl93]. Encapsulating this knowledge and communicating it in the form of design recommendations is the primary aim of our design theory. Our theory should obtain design recommendations early in the development stage, when most of the fundamental design decisions are made.*

2c. Key Objectives and Approach

In order to realize the proposed aim, we plan to:

- Develop a design theory that guides the development of applications that present heterogeneous information in diverse contexts.
- Implement prototype applications based on the theory.
- Evaluate the theory through evaluations of implemented applications.

A design theory will provide a clear definition of concepts and introduce methods for specification, optimization and evaluation of information presentation systems. As part of our design theory, we plan to develop and support with tools:

- A method for quantification of perceptual constraints. We will perform surveys of existing work and perform additional empirical studies to observe the influence of selected context on information perception. As a main tool for describing perceptual constraints, we will develop an ontology-based framework for quantification of perceptual constraints. To develop this method we will combine inductive, deductive, synthetic and collaborative techniques [Holsapple02], also building on our previous work of modelling user interfaces [Obrenovic04a, Obrenovic07a].

- A decision-support system for optimization of information presentation for a given set of perceptual constraints - a reasoning framework that takes as input a description of information structure and a description of interaction context in terms of perceptual constraints and outputs the modalities that optimally present the information. We plan to apply logic and inference techniques from the semantic web in order to draw conclusions [Antoniou04].

- A method for validation and evaluation of information presentation interfaces. This method will evaluate existing interfaces to identify potential perception problems within a given context. We will also investigate how the presence of metadata about multimedia content can be used to predict the perception of it. To develop this method, we will build on our previous work on content repurposing [Obrenovic04b].

To confirm the theory, we will implement prototype applications, and iteratively improve the theory based on the results of evaluations of the implementation. We plan to implement and use the theory through the design of applications that present rich multimedia data in a Web environment. Evaluations will include testing of implementations in different situations with users of different abilities.

We plan to work on the development of theories in a structured way, similar to those proposed in [Barnard00], where the authors propose an overlapping, layered structure of macro- and micro-theories. These could serve an explanatory role, and could bind together contributions from different disciplines. *A multi-layered approach can also ensure that some part of our approach, such as ontology of perceptual constraints, can be used even if some other parts of the theory fail.*

2d. Scientific Background

Our approach is multidisciplinary — we build on theoretical work in perceptual user interfaces, as well as on knowledge modelling and the semantic web.

Our theory builds on observations from the domain of perceptual user interfaces (PUIs), which investigates how natural human capabilities of communication, motor, cognitive and perceptual skills can be combined with computer devices, machine perception and reasoning [Turk00, Reeves00]. By using these results we will identify key factors of human information perception, going into more formal ways of describing perceptual experience and the influences of contextual factors. Here, we also build on our previous work, where we emphasized the importance of formal modelling of multimodal user interfaces [Obrenovic04a], and the benefits of combining these descriptions with descriptions of accessibility issues [Obrenovic07a, Obrenovic07b]. We also plan to reuse ideas from other areas, such as cognitive and performance models [Newell90] applied in human computer interaction applications, including Fitts' law [Fitts54, Accot97], GOMS family of models [John96], and cognitive architectures including Soar [Wray05] and ACT-R (Adaptive Control of Thought--Rational) [Anderson96]. Most of these existing theories and models are, however, applicable only at low levels of interaction, such as the key stroke level, and cannot be used to reason about higher-level properties of interaction, such as user perception. In our approach we aim at supporting analysis of higher-level perceptual effects.

We plan to apply semantic web techniques for modelling and reasoning over knowledge [Antoniou04] to realize the proposed modelling and reasoning frameworks. In this way we will be able to reuse existing tools and experiences, and make our results available to the community in a standard way.

2e. Originality and Innovation

The main innovation of our approach is in using perceptual constraints to obtain holistic view of different limitations, facilitating (semi-)automatic design of solutions applicable for a larger number of users in a broader set of situations. We treat previously separate problems in a unified way using perceptual constraints as a common basis, while most of the previous work concentrated on a specific set of disabilities, or on specific situations. We also enable a higher-level perceptual view on information presentation, in contrast to existing theories that cover only low-level interaction. Emergence of the semantic web also allows our results not to stand in isolation, but to become part of a growing knowledge repository of human factors in computing.

2f. Significance (potential contribution for science, technology, and society)

Our main contribution to science and technology is in developing an aid in coping with complexity of design of information presentation for different users and situations. In this way, both, the end-users and developers can benefit. End-users can get more effective information presentation, as the design can address user and situation specific factors. Developers can build more flexible and reusable solutions, aimed for a broader set of situations, spending fewer resources. Our design theory can, therefore, provide developers a general economic advantage over existing solutions that try to "handcraft" solutions for all possible users (dis)abilities and situations. These issues are increasingly more important for developers, who are also becoming obliged by law[3] to support information access for disabled people [Yu03].

The potential contribution of our result to society included usage of our theory to design interfaces that can improve information access for disabled people.

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[3] *List of most important policies relating to information accessibility is available at http://www.w3.org/WAI/Policy/*

2g. Plan of work

	Year 1	Year 2	Year 3
Survey and user studies	▓		
Requirements specification	▓		
Implementation		▓	
Evaluation of implementation		▓	
Feedback to the theory		▓	▓
Reporting and publishing	▓	▓	▓

During our project we will collaborate with several other research groups, including:
- Laboratory for Human Computer Interaction for Special Needs, San Sebastian, Spain — we plan to work together on the development of evaluation methods for identification of perceptual constraint on the Web;
- Stichting Bartimeus Accessibility[4], Utrecht, The Netherlands — we plan to work together on topic of evaluation of information presentation applications with disabled users;
- K-Space IST Network of Excellence[5] — working together on semantic (semi-) automatic annotation of multimedia content in terms of perceptual constraints
- World Wide Web Consortium (W3C) Web Accessibility Initiative (WAI) group[6] — giving feedback on guidelines for multimedia content on the Web.

2h. Literature references

- Accot97   Accot, J., Zhai, S. (1997). Beyond Fitts' Law: Models for Trajectory-Based HCI Tasks. Proceedings of CHI '97, Atlanta, Georgia, ACM Press.

- Anderson96   Anderson, J. R. (1996). ACT: A simple theory of complex cognition. American Psychologist, 51, 355-365.

- Antoniou04   Antoniou, G. and van Harmelen, F. 2004 A Semantic Web Primer. MIT Press.

- Baddeley90   Baddeley, A. (1990). Human Memory: Theory and Practice. London: Lawrence Erlbaum

- Barnard00   Barnard, P., May, J., Duke, D., and Duce, D. 2000. Systems, interactions, and macrotheory. ACM Trans. Comput.-Hum. Interact. 7, 2 (Jun. 2000), 222-262.

- Buxton95   Buxton, W. (1995). Speech, Language & Audition. Chapter 8 in R.M. Baecker, J. Grudin, W. Buxton and S. Greenberg, S. (Eds.) (1995). Readings in Human Computer Interaction: Toward the Year 2000, San Francisco, Morgan Kaufmann Publishers.

- Fitts54   Fitts, P.M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. Journal of Experimental Psychology, 47, 381-391.

- Gurminder04   Gurminder Singh, "Content Repurposing," IEEE MultiMedia, vol. 11, no. 1, pp. 20-21, January/March, 2004.

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[4] *http://www.bartimeus.nl/, http://www.accessibility.nl/*

[5] *http://www.k-space.eu/*

[6] *http://www.w3.org/WAI/*

- Holsapple02   Holsapple, C. W. and Joshi, K. D. 2002. A collaborative approach to ontology design. *Commun. ACM* 45, 2 (Feb. 2002), 42-47.

- John96   Bonnie E. John , David E. Kieras, "The GOMS family of user interface analysis techniques: comparison and contrast", ACM Transactions on Computer-Human Interaction (TOCHI), v.3 n.4, p.320-351, Dec. 1996

- Karl93   Karl, L., Pettey, M. & Shneiderman, B. (1993). Speech versus Mouse Commands for Word Processing: An Empirical Evaluation, International Journal of Man-Machine Studies, 39(4), 667-687.

- Miline05   Milne, S., Dickinson, A., Carmichael, A., Sloan, D., Eisma, R., and Gregor, P. 2005. "Are guidelines enough?: an introduction to designing web sites accessible to older people". *IBM Systems Journal* 44, 3 (Aug. 2005), 557-571.

- Newell90   Allen Newell, Unified Theories of Cognition, Cambridge, MA: Harvard University Press, 1990.

- Obrenovic04a   Z. Obrenovic, D. Starcevic, "Modeling Multimodal Human-Computer Interaction", IEEE Computer, Vol. 37, No. 9, September 2004, pp. 65-72.

- Obrenovic04b   Z. Obrenovic, D. Starcevic, B. Selic, "A Model-Driven Approach to Content Repurposing", IEEE Multimedia, Special Issue on Content Repurposing, Vol. 11, No. 1, January-March 2004, pp. 62-71.

- Obrenovic07a   Z. Obrenovic, R. Troncy, L. Hardman. "Vocabularies for Description of Accessibility Issues in Multimodal User Interfaces", In Workshop on Multimodal Output Generation, Aberdeen, Scotland, January 25-26, 2007

- Obrenovic07b   Z. Obrenovic, J. Abascal, D. Starcevic, "Universal Accessibility as a Multimodal Design Issue", Scheduled for publication in Communications of the ACM, May 2007.

- Reeves00   Reeves, B. and Nass, C. 2000. Perceptual user interfaces: perceptual bandwidth. Commun. ACM 43, 3 (Mar. 2000), 65-70. Byron Reeves, Clifford Nass, The media equation: how people treat computers, television, and new media like real people and places, Cambridge University Press, New York, NY, 1996

- Turk00   Turk, M. & Robertson, G. (Eds.), 2000. "Perceptual user interfaces," Communications of the ACM (special issue), 43(3), 32-70.

- Yu03   Yu, H. "Web accessibility and the law: issues in implementation" In *Design and Implementation of Web-Enabled Teaching Tools*, M. Hricko, Ed. IGI Publishing, Hershey, PA, 1-24.

- WAI   Web Accessibility Initiative (WAI) - home page, http://www.w3.org/WAI/

- Wray05   Wray, R.E., Jones, R.M. An introduction to Soar as an agent architecture. In, R. Sun (ed), Cognition and Multi-agent Interaction: From Cognitive Modeling to Social Simulation, Cambridge University Press, pp 53--78, 2005.

Cost estimates

3a. Budget

	2008	2009	2010	TOTAL
Staff costs: (in k€)				
Applicant	65,8	67,9	68	203,7
Support staff	0,0	0,0	0,0	0,0
Non staff costs: (k€)				
Equipment	0,0	0,0	0,0	0,0
Consumables				
Travel and subsistence	1,5	1,4	1,4	4,3
Other				0,0
TOTAL	67,3	69,3	71,4	208,0

3b.Indicate the time (percentage of fte) you will spend on the research
- 100%

3c. Intended starting date
- 01/01/2008

3d. Have you requested any additional grants for this project either from NWO or from any other institution?
- NO

Curriculum vitae

4a. Personal details
Title(s), initial(s), first name, surname: **Dr. Željko Obrenović**
Male/female: **Male**
Date and place of birth: **3/3/1976, Sisak, Croatia**
Nationality: **Serbia**
Birth country of parents: **Croatia (father), Bosnia and Herzegovina (mother)**

4b. Master's ('doctoraal')
University/College of Higher Education: **University of Belgrade**
Date (dd/mm/yy): **25/05/2002**
Main subject: **Optimization of Multimodal Communication for Time Critical Applications**

4c. Doctorate
University/College of Higher Education: **University of Belgrade**
Starting date (dd/mm/yy): **01/06/2002**
Completion date (dd/mm/yy): **20/10/2004** (thesis defense), **26/04/2005** (promotion)
Supervisor ('Promotor'): **Dusan Velasevic and Dusan Starcevic**
Title of thesis: **Designing User Interfaces using Unified Model of Human-Computer Interaction**

4d. Work experience since graduating
(per appointment: fte, tenured term ('vast') / fixed-term ('tijdelijk').

- *2006 - present, researcher (1.0 fte, fixed-term)*
  Centre for Mathematics and Computer Sciences (CWI)
  Amsterdam, The Netherlands

- *1999 - 2005, researcher (1.0 fte, tenured term)*
  The Centre for Command Information Systems, Belgrade, Serbia
- *2004 - 2005, assistant professor (0.2 fte, tenured term)*
  Computer Science Department, Technical Military Academy
  University of Belgrade, Belgrade, Serbia
- *2002 - 2004, lecturer (0.2 fte, fixed-term)*
  Computer Science Department, Technical Military Academy,
  University of Belgrade, Belgrade, Serbia
- *2000 - 2002 lecturer (0.2 fte, fixed-term)*
  School of Business Administration, University of Belgrade, Belgrade, Serbia
- *2000-2001, teaching assistant (0.2 fte, fixed-term)*
  College of Electrical Engineering, Belgrade, Serbia and Montenegro.

4e. Man-years of research
- 2 years and 5 months

4f. Brief summary of research over last five years

I have been doing multidisciplinary research in areas of human computer interaction, universal accessibility, software engineering and semantic web. In my PhD thesis I proposed a novel approach for designing user interfaces based on a unified model of human computer interaction. This model is developed as a part of the PhD thesis, and represents a formal description of basic concepts and relations among concepts of interest to the development of user interfaces. Using the unified model as a starting point, and by applying principles of model-driven development, I explored various approaches to the design of user interfaces. Using the concepts from the unified model it is possible to semantically extend developing environments by introducing primitives for modelling various aspect of human computer interaction at different levels of abstraction. In collaboration with other research groups, I have developed connection between the areas of multimodal interface design and universal accessibility, showing that awareness of these links can help both disciplines. The results of the research have been applied in the applications such as presentation of biomedical data and interactive television. Recent work has included the application of these ideas to the development of interactive ambient objects, such as interactive "cushions".

4g. International activities

- Participant of K-Space — a European Commission Network of Excellence (FP6-027026) in semantic inference for semi-automatic annotation and retrieval of multimedia content (http://www.k-space.eu/).

- Participant of the European ITEA Passepartout project (ITEA 04017).

- Member of the World Wide Web Consortium (W3C) Multimedia Semantics Incubator Group (http://www.w3.org/2005/Incubator/mmsem/)

- Program committee member for international conferences:
  o International Cross-Disciplinary Conference on Web Accessibility - W4A (2007)
  o International Workshop on Semantic-enhanced Multimedia Presentation Systems (2006)
  o International Workshop on Task, Models and Diagrams for UI Design - TAMODIA (2006)
  o IFIP Conference on Artificial Intelligence Applications & Innovations - AIAI (2006, 2005, 2004)
  o Conference on Articulated Motion and Deformable Objects (2006)

4h. Other academic activities

- Visiting Lecturer, Laboratory of HCI for Special Needs, University of the Basque Country, San Sebastian, Spain, Fall 2004

4i. Scholarships and prizes

- June 2006 - Recognized as a multimodal interface "guru" by SIMILAR, European Network of Excellence (FP6-507609) dedicated to multimodal interfaces (http://www.similar.cc/)

- January 2000 – January 2002 – M.S. scholarship grant (first in rank) from The Ministry of Science, Research, and Technology, The Government of Serbia

List of publications

5. Publications:

- International (refereed) journals

1. **Ž. Obrenović**, D. Gašević, "Open-Source Software: All you do is put it together", IEEE Software, *in press (expected publication date at the end of 2007)*.

2. **Ž. Obrenović**, J. Abascal, D. Starcevic, "Universal Accessibility as a Multimodal Design Issue", *Communications of the ACM*, Vol. 50, No. 5 (May 2007).

3. **Ž. Obrenović**, D. Starčević, "Adapting the Unified Software Development Process for User Interface Development", *Computer Science and Information Systems*, Vol. 03, No. 01 (June 2006), pp. 33-52.

4. **Ž. Obrenović**, D. Starcevic, "Modeling Multimodal Human-Computer Interaction", *IEEE Computer*, Vol. 37, No. 9, September 2004, pp. 65-72.

5. **Ž. Obrenović**, D. Starčević, B. Selić, "A Model Driven Approach to Content Repurposing", *IEEE Multimedia*, Vol. 11, No. 1, January-March 2004, pp. 62-71.

6. **Ž. Obrenović**, "Experimental evaluation of user performance in a pursuit tracking task with multimodal feedback", *Yugoslav Journal of Operations Research* 14 (2004), Number 1, pp. 99-115.

7. E. Jovanov, D. Starčević, A. Samardžić, A. Marsh, **Ž. Obrenović**, "EEG analysis in a telemedical virtual world", *Future Generation Computer Systems* 15 (1999), pp. 255-263.

- Books, or contributions to books

1. **Ž. Obrenović**, D. Starcevic, E. Jovanov, "Multimodal presentation of Biomedical Data", in Metin Akay (Editor): *Wiley Encyclopedia of Biomedical Engineering*, Wiley, 2006, ISBN: 0-471-24967-X, DOI: 10.1002/9780471740360.ebs1325.

2. **Ž. Obrenović**, D. Starcevic, E. Jovanov, "Virtual Instrumentation", in Metin Akay (Editor): *Wiley Encyclopedia of Biomedical Engineering*, Wiley, 2006, ISBN: 0-471-24967-X, DOI: 10.1002/9780471740360.ebs1265.

3. **Ž. Obrenović**, *Human-Computer Interaction*, FON: TEMPUS, Belgrade, 2004, ISBN 86-7680-027-8, (in Serbian, adapted PhD Thesis).

4. **Ž. Obrenović**, D. Starcevic, "History of Human-Computer Interaction", In Devedzic, V. (ed.) *Intelligent System Technologies*, FON – School of Business Administration & TEMPUS, Belgrade, 2004, pp. 73-90, ISBN 86-7680-026-X (in Serbian).

5. D. Starčević, E. Jovanov, V. Radivojević, **Ž. Obrenović**, A. Samardžić, "Virtual medical devices for telemedical applications", in P. Spasić, I. Milosavljević, M. Jancic-Zguricas (Eds.), *Telemedicine*, Academy of Medical Sciences of Serbian Medical Association, Belgrade, Yugoslavia, 2000, pp. 218-244.

6. D. Starčević, V. Radivojević, **Ž. Obrenović**, E. Jovanov, A. Samardžić, "Technological breakthroughs in neurophysiology: Virtual medical devices for EEG analysis", in Ilankovic (Ed.): *Consciousness, sleeping, dreams*, Belgrade, 1999, pp. 145-158.

- International (referred) conference papers

1. **Ž. Obrenović** and Jacco van Ossenbruggen, "Web Browser Accessibility using Open Source Software", in *Proceedings of International Cross-Disciplinary Conference on Web Accessibility (W4A) 2007*, May 07–08, 2007, Banff, Canada. Co-Located with the 16th International World Wide Web Conference, pp. 11-20.

2. **Ž. Obrenović**, Nestor Garay, Juan Miguel López, Inmaculada Fajardo, Idoia Cearreta, "An Ontology for Description of Emotional Cues", in Jianhua Tao, Tieniu Tan, Rosalind W. Picard (Eds.): *Affective Computing and Intelligent Interaction, First International Conference*, ACII 2005, Beijing, China, October 22-24, 2005, Proceedings. Lecture Notes in Computer Science 3784 Springer 2005, pp. 505-512.

3. **Z. Obrenovic**, **"**A flexible system for creating music while interacting with the computer", In *Proceedings of the 13th Annual ACM international Conference on Multimedia* (Hilton, Singapore, November 06 - 11, 2005). MULTIMEDIA '05. ACM Press, New York, NY, pp. 996-1004.

4. **Ž. Obrenović**, D. Starcevic, Vladan Devedzic, "Using Ontologies in Design of Multimodal User Interfaces", in M. Rauterberg, M. Menozzi, and J. Wesson (Eds.): *Proceedings of the Ninth IFIP TC13 International Conference on Human-Computer Interaction - INTERACT '03*, IOS Press & IFIP, 2003, pp. 535-542.

5. **Ž. Obrenović**, D. Starcevic, E. Jovanov, "Experimental Evaluation of Multimodal Human Computer Interface for Tactical Audio Applications", *Proceedings of IEEE International Conference on Multimedia and Expo - ICME 2002*, Lausanne, Switzerland, August 26-29 2002, Volume 2, pp. 29-32.

6. **Ž. Obrenović**, D. Starcevic, E. Jovanov, Vlada Radivojevic, "An Agent Based Framework for Virtual Medical Devices", In *Proceedings of the First international Joint Conference on Autonomous Agents and Multiagent Systems: Part 2* (Bologna, Italy, July 15 - 19, 2002). AAMAS '02. ACM Press, New York, NY, pp. 659-660.

7. M. Marković, Z. Savić, **Ž. Obrenović,** A. Nikolić, "A PC Cryptographic Coprocessor Based on TI Signal Processor and SMarch Card System", *In Proceedings of the IFIP Tc6/Tc11 international Conference on Communications and Multimedia Security Issues of the New Century* (May 21 - 22, 2001). R. Steinmetz, J. Dittmann, and M. Steinebach, Eds. IFIP Conference Proceedings, vol. 192. Kluwer B.V., Deventer, The Netherlands, 3.

8. E. Jovanov, D. Starcevic, A. Marsh, **Ž. Obrenović**, V. Radivojevic, A. Samardzic, "Multi modal presentation in virtual telemedical environments", In *Proceedings of the 7th international Conference on High-Performance Computing and Networking* (April 12 - 14, 1999). P. M. Sloot, M. Bubak, A. G. Hoekstra, and B. Hertzberger, Eds. Lecture Notes In Computer Science, vol. 1593. Springer-Verlag, London, pp. 964-972.

9. E. Jovanov, D. Starčević, A. Marsh, A. Samardžić, **Ž. Obrenović**, V. Radivojević, "Multimodal Viewer for Telemedical Applications", *in Proceedings of the 20th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, Volume 3, 29 Oct-1 Nov 1998, pp. 1254 - 1257.

- Other publications

International (refereed) workshops

1. **Ž. Obrenović**, Raphaël Troncy and Lynda Hardman. "Vocabularies for Description of Accessibility Issues in Multimodal User Interfaces", In I. van der Sluis, M. Theune, E. Reiter, E. Krahmer (Eds.): *Proceedings of the Workshop on Multimodal Output Generation*, Aberdeen, Scotland, January 25-26, 2007, CTIT Workshop Proceedings Series WP07-01, pp. 117-128.

2. **Ž. Obrenović**, D. Starcevic, E. Jovanov, "Toward Optimization of Multimodal User Interfaces for Tactile Audio Applications", Chapter in N. Carbonell, C. Stephanidis (Eds.): *Universal Access Theoretical Perspectives, Practice, and Experience - Lecture Notes in Computer Sciences 2615* (Proceedings of the ERCIM Workshop User Interfaces For All), Springer, 2003, pp. 287-298.

3. **Ž. Obrenović**, D. Starcevic, E. Jovanov, Vlada Radivojevic, "Implementation of Virtual Medical Devices in Internet and Wireless Cellular Networks", *in Proceedings of the IFIP Tc6/Wg6.4 Workshop on internet Technologies, Applications and Social Impact (October 10 - 11, 2002). W. Cellary and A. Iyengar, Eds. IFIP Conference Proceedings, vol. 232.* Kluwer B.V., Deventer, The Netherlands, pp. 229-242.

4. **Ž. Obrenović**, D. Starcevic, E. Jovanov, V. Radivojevic, "An Implementation of Real-time Monitoring and Analysis in Telemedicine", *Third IEEE EMBS Information Technology Applications in Biomedicine – Workshop of the International Telemedical Information Society ITAB-ITIS 2000*, Arlington, Virginia, November 2000, pp. 74-78.

National (refereed) journals

1. **Ž. Obrenović**, D. Starčević E. Jovanov, "Optimization of Multimodal Communication for Tactical Audio Applications", *InfoM*, Vol. 1, No. 1.

2. M. Merdžanović, N. Ostojić, **Ž. Obrenović**, "An application for supporting military sport competitions", *Military technical journal*, Vojnoizdavački zavod, Belgrade, No. 2, Vol. 2003, pp. 182-183.

3. Z. Savić, **Ž. Obrenović**, "Protecting Data in the State Agencies' Networks", *INFO science*, 1-2 (2000), pp. 41-45.

4. D. Starčević, **Ž. Obrenović**, E. Jovanov, D. Karron, "Tactical Audio Training System based on Virtual Reality", *INFO science*, 6/99 (1999), pp. 4-7.

National (referred) conference papers

1. D. Starčević, **Ž. Obrenović,** V. Radivojević, "Multimodal Neural Feedback", *XXX Yugoslav Symposium of Operational Research - SYMOPIS 2003*, Herceg Novi, Serbia and Montenegro, 30. September - 03. October 2003.

2. **Ž. Obrenović**, V. Jovanović, I. Martić, "Selective Access to SQL Server databases: An Integrative Approach", *XVIII Information Technology Conference - InfoTech 2003*, Vrnjačka Banja, Serbia and Montenegro, 26-30. May 2003.

3. V. Štavljanin, M. Minović, D. Starčević, **Ž. Obrenović**, "Applying WAP 2.0 technologies in banking", *XVIII Information Technology Conference - InfoTech 2003*, Vrnjačka Banja, Serbia and Montenegro, 26-30. May 2003.

4. D. Gašević, **Ž. Obrenović,** "An Approach to Integration of Structured Data Sources Based on Metamodel Transformations ", *YUINFO Conference 2003*, Kopaonik, Serbia and Montenegro, 10-14. March 2003.

5. **Ž. Obrenović,** D. Starčević, V. Štavljanin, V. Batalov, "Applying WAP/SMS Technologies in Banking", *X Telecommunications Forum - TELFOR 2002*, Belgrade, Serbia and Montenegro, 10-14. March 2003, 26-28. 11. 2002.

6. N. Ostojić, **Ž. Obrenović,** M. Merdžanović, N. Dulanović, Z. Ružić, "Web-based Information Support of SYMOPIS 2001 Conference: Lessons Learned", *XXIX Yugoslav Symposium of Operational Research* - SYMOPIS 2002, 10-14. March 2003, Tara, Serbia and Montenegro, 09. - 12. October 2002, pp. VI-5 - VI-8.

7. M. Merdžanović, **Ž. Obrenović,** D. Hinić, "Web-based Information Support of Sport Competitions", *XXIX Yugoslav Symposium of Operational Research* - SYMOPIS 2002, Tara, Serbia and Montenegro, 09. - 12. October 2002, pp. VI-13 - VI-16.

8. **Ž. Obrenović,** D. Starčević, E. Jovanov, "Experimental Evaulation of Multimodal Interfaces for Tactical Audio Applications", *XVII Information Technology Conference – InfoTech 2002*, Vrnjačka Banja, Serbia and Montenegro, 17-21. June 2002.

9. D. Starcevic, **Ž. Obrenović**, E. Jovanov, Vlada Radivojevic, "Virtual Medical Devices in Internet and Wireless Cellular Networks", 6th Balkan Conference on Operational Research, Thesaloniki, Greece, May 2002.

10. **Ž. Obrenović,** D. Starčević, E. Jovanov, V. Radivojević, "Virtual Medical Devices for Monitoring and Analysis of EEG signals based on Internet and Cellular Network Technologies", *XVI Information Technology Conference – InfoTech 2001*, 19-22. June 2001, Vrnjačka Banja, Serbia and Montenegro, ISBN 86-82831-07-4.

11. V. Batalov, V. Štavljanin, **Ž. Obrenović**, "Mobile Counter", *XVI Information Technology Conference – InfoTech 2001*, 19-22. June 2001, Vrnjačka Banja, Serbia and Montenegro, ISBN 86-82831-07-4.

12. G. Barać, Ž. Stanković, **Ž. Obrenović**, S. Novaković, I. Martić, N. Novaković, "Developing Military Human Resources Management Information System: Lessons Learned", *XVI Information Technology Conference – InfoTech* 2001, 19-22. June 2001, Vrnjačka Banja, Serbia and Montenegro, ISBN 86-82831-07-4.

13. **Ž. Obrenović,** D. Starčević, E. Jovanov, V. Radivojević, "A Web-based Solution for Real-time EEG Monitoring and Analysis", *YUINFO Conference 2001*, Kopaonik, Serbia and Montenegro, 19-23.03.2001.

14. **Ž. Obrenović,** D. Radović, "A Web-based Solution for Acquisition, Analysis and Presentation of Metrological Data", *VIII Telecommunications Forum - TELFOR 2000*, Belgrade, Serbia and Montenegro, 21-22.11.2000, pp. 29-32.

15. **Ž. Obrenović,** N. Ostojić, M. Živanović, M. Đurašinović, "Information Support of Marathon Competitions: A Web-based Approach", *YUINFO Conference 2000,* Kopaonik, Serbia and Montenegro, 2000.

16. N. Ostojić, **Ž. Obrenović,** Milorad Živanović, Dragan Strelić, Mlađen Đurašinović, "Web Based Information Processing Support for Sportsmen Competitions", 5*th Balkan Conference on Operational Research, Banja Luka, Bosnia and Hercegovina, May 2000.*

17. E. Jovanov, **Ž. Obrenović**, D. Starcevic, D.B. Karron, "A Virtual Reality Training System for Tactical Audio Applications", *In Proceedings of SouthEastern Simulation Conference*, SESC'99, Huntsville, Alabama, Oct 1999, pp. 149-154.

18. **Ž. Obrenović,** N. Ostojić, M. Đurašinović, Đ. Vojnović, "Information Support of Shooting Competitions: A Web-based Approach", *XLIII ETRAN Conference 1999*, Zlatibor, Serbia and Montenegro, 20-22. September 1999.

19. N. Ostojić, **Ž. Obrenović**. . . , "Information Support of Shooting Competitions: Lessons Learned", *XLIII ETRAN Conference 1999*, Zlatibor, Serbia and Montenegro, 20-22. September 1999.

20. **Ž. Obrenović,** "An approach to server activities monitoring based on distributed software agents", *VI Telecommunications Forum - TELFOR'98*, Belgrade, Serbia and Montenegro, 24-26. Novembar 1998, pp. 350-353.

21. E. Jovanov, D. Starčević, V. Radivojević, **Ž. Obrenović**, A. Samardžić, "Visualization and Sonification of Biomedical Data", *Conference on Informatics in Medicine, Pharmacy, and Social Protection - IFM'98*, Aranđelovac, Serbia and Montenegro, 19-23. May, 1998, pp. 19-24 (pozvano predavanje).

22. **Ž. Obrenović**, "The Software System for Supporting Email Access to Internet Services", *V Telecommunications Forum - TELFOR'97*, Belgrade, Serbia and Montenegro, 25-27. novembar 1997, pp. 337-340.

23. **Ž. Obrenović**, "Preparing Email Messages for Accessing Internet Services", *SINFON Conference 1997*, Zlatibor, Serbia and Montenegro, 14-17. novembar 1997, pp. 33.

24. **Ž. Obrenović**, "An Object-oriented Approach to Development of Graphical Interface for Information System Modeling", *SINFON Conference 1996*, Zlatibor, Serbia and Montenegro, 8-11. novembar 1996, pp. 10.

25. **Ž. Obrenović**, M. Majstorović, B. Milovanović, "Development of the System for Evaluation of Artilery Actions: An Object-Oriented Approach", *XXIII Yugoslav Symposium of Operational Research - SYMOPIS 1996*, Žabljak, Serbia and Montenegro, 1996, pp. 969-972.

Signature

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