

Proceedings

**2013 Humaine Association Conference
on Affective Computing
and Intelligent Interaction
ACII 2013**

**2-5 September 2013
Geneva, Switzerland**



Los Alamitos, California
Washington • Tokyo



All rights reserved.

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries may photocopy beyond the limits of US copyright law, for private use of patrons, those articles in this volume that carry a code at the bottom of the first page, provided that the per-copy fee indicated in the code is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

Other copying, reprint, or republication requests should be addressed to: IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, P.O. Box 133, Piscataway, NJ 08855-1331.

The papers in this book comprise the proceedings of the meeting mentioned on the cover and title page. They reflect the authors' opinions and, in the interests of timely dissemination, are published as presented and without change. Their inclusion in this publication does not necessarily constitute endorsement by the editors, the IEEE Computer Society, or the Institute of Electrical and Electronics Engineers, Inc.

IEEE Computer Society Order Number E5048
BMS Part Number CFP1364H-ART
ISBN 978-0-7695-5048-0

Additional copies may be ordered from:

IEEE Computer Society
Customer Service Center
10662 Los Vaqueros Circle
P.O. Box 3014
Los Alamitos, CA 90720-1314
Tel: + 1 800 272 6657
Fax: + 1 714 821 4641
<http://computer.org/cspress>
csbooks@computer.org

IEEE Service Center
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
Tel: + 1 732 981 0060
Fax: + 1 732 981 9667
[http://shop.ieee.org/store/
customer-service@ieee.org](http://shop.ieee.org/store/customer-service@ieee.org)

IEEE Computer Society
Asia/Pacific Office
Watanabe Bldg., 1-4-2
Minami-Aoyama
Minato-ku, Tokyo 107-0062
JAPAN
Tel: + 81 3 3408 3118
Fax: + 81 3 3408 3553
tokyo.ofc@computer.org

Individual paper REPRINTS may be ordered at: <reprints@computer.org>

Editorial production by Juan E. Guerrero
Cover art production by Zoey Vegas
Printed in the United States of America by Applied Digital Imaging



IEEE Computer Society
Conference Publishing Services (CPS)

<http://www.computer.org/cps>

2013 Humaine Association Conference on Affective Computing and Intelligent Interaction

ACII 2013

Table of Contents

Foreword.....	xviii
Organizing Committee.....	xxi
Keynotes.....	xxvii

Main Conference—Full Papers

A Computational Model of Empathy: Empirical Evaluation	1
<i>Hana Boukricha, Ipke Wachsmuth, Maria Nella Carminati, and Pia Knoeferle</i>	
A Control-Theoretic Approach to Adaptive Physiological Games	7
<i>Avinash Parnandi, Youngpyo Son, and Ricardo Gutierrez-Osuna</i>	
A Large Video Data Base for Computational Models of Induced Emotion	13
<i>Yoann Baveye, Jean-Noël Bettinelli, Emmanuel Dellandréa, Liming Chen, and Christel Chamaret</i>	
A Multimodal Corpus Approach to the Design of Virtual Recruiters	19
<i>Mathieu Chollet, Magalie Ochs, Chloé Clavel, and Catherine Pelachaud</i>	
A Preliminary Investigation of the Effect of Social Media on Affective Trust in Customer-Supplier Relationships	25
<i>Fabio Calefato, Filippo Lanubile, and Nicole Novielli</i>	
A Preliminary Study on GMM Weight Transformation for Emotional Speaker Recognition	31
<i>Li Chen and Yingchun Yang</i>	
A Probabilistic Approach to Tweets' Sentiment Classification	37
<i>Francesco Colace, Massimo De Santo, and Luca Greco</i>	
Assessing Emotion Patterns from Affective Interactions Using Electrodermal Activity	43
<i>Rui Henriques, Ana Paiva, and Cláudia Antunes</i>	

Action Unit Models of Facial Expression of Emotion in the Presence of Speech	49
<i>Miraj Shah, David G. Cooper, Houwei Cao, Ruben C. Gur, Ani Nenkova, and Ragini Verma</i>	
Active Labeling of Facial Feature Points	55
<i>Menghua He, Shangfei Wang, and Qiang Ji</i>	
Addressing Loneliness and Isolation in Older Adults: Proactive Affective Agents Provide Better Support	61
<i>Lazlo Ring, Barbara Barry, Kathleen Totzke, and Timothy Bickmore</i>	
Affect and Creative Performance on Crowdsourcing Platforms	67
<i>Robert R. Morris, Mira Dontcheva, Adam Finkelstein, and Elizabeth Gerber</i>	
Affective Benchmarking of Movies Based on the Physiological Responses of a Real Audience	73
<i>Julien Fleureau, Philippe Guillotel, and Izabela Orlac</i>	
Analyses of the Differences between Posed and Spontaneous Facial Expressions	79
<i>Menghua He, Shangfei Wang, Zhilei Liu, and Xiaoping Chen</i>	
Analysis and Compensation of the Reaction Lag of Evaluators in Continuous Emotional Annotations	85
<i>Soroosh Mariooryad and Carlos Busso</i>	
Analysis and Modelling of Affective Japanese Sitting Postures by Japanese and British Observers	91
<i>Tatsuya Shibata, Akito Michishita, and Nadia Bianchi-Berthouze</i>	
Are Discrete Emotions Useful in Human-Robot Interaction? Feedback from Motion Capture Analysis	97
<i>Matthew Lewis and Lola Cañamero</i>	
Arguments for a Computational Model for Forms of Selective Attention Based on Cognitive and Affective Feelings	103
<i>Luis Macedo</i>	
Assessing Postural Control for Affect Recognition Using Video and Force Plates	109
<i>Tom Giraud, David Antonio Gómez Jáuregui, Jiewen Hua, Brice Isableu, Edith Filaire, Christine Le Scanff, and Jean Claude Martin</i>	
Assessment of Computer-Supported Collaborative Processes Using Interpersonal Physiological and Eye-Movement Coupling	116
<i>Guillaume Chanel, Mireille Bétrancourt, Thierry Pun, Donato Cereghetti, and Gaëlle Molinari</i>	
Audiovisual Detection of Behavioural Mimicry	123
<i>Sanjay Bilakhia, Stavros Petridis, and Maja Pantic</i>	

Audiovisual Detection of Laughter in Human-Machine Interaction	129
<i>Stavros Petridis, Maelle Leveque, and Maja Pantic</i>	
AutoBAP: Automatic Coding of Body Action and Posture Units from Wearable Sensors	135
<i>Eduardo Velloso, Andreas Bulling, and Hans Gellersen</i>	
Automatic Classification of Literature Pieces by Emotion Detection: A Study on Quevedo's Poetry	141
<i>Linda Barros, Pilar Rodriguez, and Alvaro Ortigosa</i>	
Automatic Nonverbal Behavior Indicators of Depression and PTSD: Exploring Gender Differences	147
<i>Giota Stratou, Stefan Scherer, Jonathan Gratch, and Louis-Philippe Morency</i>	
Automatic Phonetic Transcription of Laughter and Its Application to Laughter Synthesis	153
<i>Jérôme Urbain, Hüseyin Çakmak, and Thierry Dutoit</i>	
Automatically Recognizing Facial Indicators of Frustration: A Learning-centric Analysis	159
<i>Joseph F. Grafsgaard, Joseph B. Wiggins, Kristy Elizabeth Boyer, Eric N. Wiebe, and James C. Lester</i>	
Bayesian Affect Control Theory	166
<i>Jesse Hoey, Tobias Schroder, and Areej Alhothali</i>	
Bayesian Inference Based Temporal Modeling for Naturalistic Affective Expression Classification	173
<i>Linlin Chao, Jianhua Tao, Minghao Yang, and Ya Li</i>	
Bodily Manifestations of Affects: The Example of Gait and Virtual Reality	179
<i>Vincent Krieger, Elise Lallart, and Roland Jouvent</i>	
Computational Analysis of Emotion Dynamics	185
<i>Ayesha Hakim, Stephen Marsland, and Hans W. Guesgen</i>	
Contactless Measurement of Heart Rate Variability from Pupillary Fluctuations	191
<i>Avinash Parnandi and Ricardo Gutierrez-Osuna</i>	
Continuous Emotion Recognition: Another Look at the Regression Problem	197
<i>Pouria Fewzee and Fakhri Karray</i>	
Conversational Topics Handle Social Relationships	203
<i>Jean-Paul Sansonnet</i>	
Does Learner Conscientiousness Matter When Generating Emotional Support in Feedback?	209
<i>Matt Dennis, Judith Masthoff, and Chris Mellish</i>	
EmotionAir: Perception of Emotions from Air Jet Based Tactile Stimulation	215
<i>Mohamed Yassine Tsalamlal, Nizar Ouarti, Jean-Claude Martin, and Mehdi Ammi</i>	

Event-Driven Fuzzy Automata for Tracking Changes in the Emotional Behavior of Affective Agents	221
<i>Ahmad Soleimani and Ziad Kobti</i>	
Exploring Eye-Blink Startle Response as a Physiological Measure for Affective Computing	227
<i>Luca Chittaro and Riccardo Sioni</i>	
Expressive Non-verbal Interaction in String Quartet	233
<i>Donald Glowinski, Giorgio Gnecco, Stefano Piana, and Antonio Camurri</i>	
Facial Expression Recognition Using Deep Boltzmann Machine from Thermal Infrared Images	239
<i>Shan He, Shangfei Wang, Wuwei Lan, Huan Fu, and Qiang Ji</i>	
Facing Imbalanced Data--Recommendations for the Use of Performance Metrics	245
<i>László A. Jeni, Jeffrey F. Cohn, and Fernando De La Torre</i>	
Food and Mood: Just-in-Time Support for Emotional Eating	252
<i>Erin A. Carroll, Mary Czerwinski, Asta Roseway, Ashish Kapoor, Paul Johns, Kael Rowan, and M.C. Schraefel</i>	
From Emotions to Interpersonal Stances: Multi-level Analysis of Smiling Virtual Characters	258
<i>Magalie Ochs, Ken Prepin, and Catherine Pelachaud</i>	
Fusion of Smile, Valence and N-Gram Features for Automatic Affect Detection	264
<i>Ovidiu Serban, Ginevra Castellano, Alexandre Pauchet, Alexandrina Rogozan, and Jean-Pierre Pecuchet</i>	
HapFACS: An Open Source API/Software to Generate FACS-Based Expressions for ECAs Animation and for Corpus Generation	270
<i>Reza Amini and Christine Lisetti</i>	
Head Movement Dynamics during Normal and Perturbed Parent-Infant Interaction	276
<i>Zakia Hammal, Jeffrey F. Cohn, Daniel S. Messinger, Whitney I. Mattson, and Mohammad H. Mahoor</i>	
Head Pose and Movement Analysis as an Indicator of Depression	283
<i>Sharifa Alghowinem, Roland Goecke, Michael Wagner, Gordon Parkerx, and Michael Breakspear</i>	
Heart Rate Variability and Skin Conductance Biofeedback: A Triple-Blind Randomized Controlled Study	289
<i>S.F. Raaijmakers, F.W. Steel, M. de Goede, N.C. van Wouwe, J.B.F. van Erp, and A.-M. Brouwer</i>	
How Action Adapts to Social Context: The Movements of Musicians in Solo and Ensemble Conditions	294
<i>Donald Glowinski, Maurizio Mancini, Roddie Cowie, and Antonio Camurri</i>	

How Virtual Teammate Support Types Affect Stress	300
<i>Peter Kindness, Chris Mellish, and Judith Masthoff</i>	
Human Perception of Laughter from Context-Free Whole Body Motion Dynamic Stimuli	306
<i>Gary McKeown, William Curran, Denise Kane, Rebecca Mccahon, Harry J. Griffin, Ciaran McLoughlin, and Nadia Bianchi-Berthouze</i>	
Hybrid Deep Neural Network--Hidden Markov Model (DNN-HMM) Based Speech Emotion Recognition	312
<i>Longfei Li, Yong Zhao, Dongmei Jiang, Yanning Zhang, Fengna Wang, Isabel Gonzalez, Enescu Valentin, and Hichem Sahli</i>	
In My Shoes--A Computer Assisted Interview for Communicating with Children about Emotions	318
<i>Floriana Grasso, Katie Atkinson, and Phil Jimmieson</i>	
Investigating the Impact of Language Style and Vocal Expression on Social Roles of Participants in Professional Meetings	324
<i>Ashtosh Sapru and Herve Bourlard</i>	
Is It Time to Rethink Motion Artifacts? Temporal Relationships between Electrodermal Activity and Body Movements in Real-Life Conditions	330
<i>Ryad Chellali and Shannon Hennig</i>	
Judging Emotion from Low-Pass Filtered Naturalistic Emotional Speech	336
<i>John Snel and Charlie Cullen</i>	
Laban Effort and Shape Analysis of Affective Hand and Arm Movements	343
<i>Ali-Akbar Samadani, Sarahjane Burton, Rob Gorbet, and Dana Kulic</i>	
Laughter Type Recognition from Whole Body Motion	349
<i>Harry J. Griffin, Min S.H. Aung, Bernardino Romera-Paredes, Ciaran McLoughlin, Gary McKeown, William Curran, and Nadia Bianchi-Berthouze</i>	
Local Gabor Binary Patterns from Three Orthogonal Planes for Automatic Facial Expression Recognition	356
<i>Timur R. Almaev and Michel F. Valstar</i>	
Measuring Emotional Arousal for Online Applications: Evaluation of Ultra-short Term Heart Rate Variability Measures	362
<i>Kristina Schaaff and Marc T.P. Adam</i>	
Measuring Voter's Candidate Preference Based on Affective Responses to Election Debates	369
<i>Daniel McDuff, Rana El Kaliouby, Evan Kodra, and Rosalind Picard</i>	
Micro-blogging Content Analysis via Emotionally-Driven Clustering	375
<i>Despoina Chatzakou, Vassiliki Koutsonikola, Athena Vakali, and Konstantinos Kafetsios</i>	

Modeling Framing Effects: Comparing an Appraisal-Based Model with Existing Models	381
<i>Jonathan Ito and Stacy Marsella</i>	
Modeling Stress Using Thermal Facial Patterns: A Spatio-temporal Approach	387
<i>Nandita Sharma, Abhinav Dhall, Tom Gedeon, and Roland Goecke</i>	
Modelling Context to Solve Conflicts in SentiWordNet	393
<i>Ovidiu Serban, Alexandre Pauchet, Alexandrina Rogozan, and Jean-Pierre Pecuchet</i>	
Mouse Trajectories and State Anxiety: Feature Selection with Random Forest	399
<i>Takashi Yamauchi</i>	
Multimodal Emotion Expressions of Virtual Agents, Mimic and Vocal Emotion Expressions and Their Effects on Emotion Recognition	405
<i>Benny Liebold and Peter Ohler</i>	
Multimodal Engagement Classification for Affective Cinema	411
<i>Mojtaba Khomami Abadi, Jacopo Staiano, Alessandro Cappelletti, Massimo Zancanaro, and Nicu Sebe</i>	
Multimodal Expressions of Stress during a Public Speaking Task: Collection, Annotation and Global Analyses	417
<i>Tom Giraud, Mariette Soury, Jiewen Hua, Agnes Delaborde, Marie Tahon, David Antonio Gomez Jauregui, Victoria Eyharabide, Edith Filaire, Christine Le Scanff, Laurence Devillers, Brice Isabelleu, and Jean Claude Martin</i>	
Mutual Behaviors during Dyadic Negotiation: Automatic Prediction of Respondent Reactions	423
<i>Sunghyun Park, Stefan Scherer, Jonathan Gratch, Peter Carnevale, and Louis-Philippe Morency</i>	
Neuroticism, Extraversion and Stress: Physiological Correlates	429
<i>Anne-Marie Brouwer, Martin van Schaik, Jan van Erp, and Hans Korteling</i>	
Non-anthropomorphic Expression of Affective States through Parametrized Abstract Motifs	435
<i>Alberto Betella, Martin Inderbitzin, Ulysses Bernardet, and Paul F.M.J. Verschure</i>	
On Recovering Structure of Affect	442
<i>Ashish Kapoor, Mary Czerwinski, Diana Lynn Maclean, and Alex Zolotovitski</i>	
On the Influence of Emotional Feedback on Emotion Awareness and Gaze Behavior	448
<i>Fabien Ringeval, Andreas Sonderegger, Basilio Noris, Aude Billard, Juergen Sauer, and Denis Lalanne</i>	
Parameter Optimization Issues for Cross-corpora Emotion Classification	454
<i>Bogdan Vlasenko, David Philippou-Hübner, and Andreas Wendemuth</i>	

Perception of Emotional Gaits Using Avatar Animation of Real and Artificially Synthesized Gaits	460
<i>Halim Hicheur, Hideki Kadone, Julie Grèzes, and Alain Berthoz</i>	
PERSEED: A Self-Based Model of Personality for Virtual Agents Inspired by Socio-cognitive Theories	467
<i>Caroline Faur, Céline Clavel, Sylvie Pesty, and Jean-Claude Martin</i>	
Physiological Correlates of Stress in Individuals about to Undergo Eye Laser Surgery	473
<i>Maarten A. Hogervorst, Anne-Marie Brouwer, and Wouter K. Vos</i>	
Reading Personality: Avatar vs. Human Faces	479
<i>Yuqiong Wang, Joe Geigel, and Andrew Herbert</i>	
Real-Time LDCRF-Based Method for Inferring TV Viewer Interest	485
<i>Masahide Naemura, Simon Clippingdale, Masaki Takahashi, Makoto Okuda, Yuko Yamanouchi, and Mahito Fujii</i>	
Relative Body Parts Movement for Automatic Depression Analysis	492
<i>Jyoti Joshi, Abhinav Dhall, Roland Goecke, and Jeffrey F. Cohn</i>	
Reversal Learning Based on Somatic Markers	498
<i>Jens Hoefinghoff and Josef Pauli</i>	
Some Correlates of Agency Ascription and Emotional Value and Their Effects on Decision-Making	505
<i>Megan Strait, Gordon Briggs, and Matthias Scheutz</i>	
Sparse Autoencoder-Based Feature Transfer Learning for Speech Emotion Recognition	511
<i>Jun Deng, Zixing Zhang, Erik Marchi, and Björn Schuller</i>	
Statistical Modelling of Complex Emotions Using Mixture of Von Mises Distributions	517
<i>Ayesha Hakim, Stephen Marsland, and Hans W. Guesgen</i>	
Stress Detection for PTSD via the StartleMart Game	523
<i>Christoffer Holmgård, Georgios N. Yannakakis, Karen-Inge Karstoft, and Henrik Steen Andersen</i>	
Stress Detection from Audio on Multiple Window Analysis Size in a Public Speaking Task	529
<i>Mariette Soury and Laurence Devillers</i>	
Student Emotions with an Edu-game: A Detailed Analysis	534
<i>Mirela Gutica and Cristina Conati</i>	
Subjective Perceptions in Wartime Negotiation	540
<i>Ning Wang, David V. Pynadath, and Stacy C. Marsella</i>	

The Effect of Agency on the Impact of Emotion Expressions on People's Decision Making	546
<i>Celso M. de Melo, Jonathan Gratch, and Peter J. Carnevale</i>	
The Perception of Charisma from Voice: A Cross-Cultural Study	552
<i>Francesca D'Errico, Rosario Signorello, Didier Demolin, and Isabella Poggi</i>	
The Relative Importance and Interrelations between Behavior Parameters for Robots' Mood Expression	558
<i>Junchao Xu, Joost Broekens, Koen Hindriks, and Mark A. Neerincx</i>	
Towards Ambulatory Mental Stress Measurement from Physiological Parameters	564
<i>Jacqueline Wijsman, Ruud Vullers, Salvatore Polito, Carlos Agell, Julien Penders, and Hermie Hermens</i>	
Towards Robust Real-Time Valence Recognition from Facial Expressions for Market Research Applications	570
<i>Jens-Uwe Garbas, Tobias Ruf, Matthias Unfried, and Anja Dieckmann</i>	
Towards the Design of Affective Survival Horror Games: An Investigation on Player Affect	576
<i>Vanus Vachiratamporn, Roberto Legaspi, Koichi Moriyama, and Masayuki Numao</i>	
User-centric Affective Video Tagging from MEG and Peripheral Physiological Responses	582
<i>Mojtaba Khomami Abadi, Seyed Mostafa Kia, Ramanathan Subramanian, Paolo Avesani, and Nicu Sebe</i>	
Using a Probabilistic Topic Model to Link Observers' Perception Tendency to Personality	588
<i>Shiro Kumano, Kazuhiro Otsuka, Masafumi Matsuda, Ryo Ishii, and Junji Yamato</i>	
VibeRate, An Affective Wearable Tool for Creative Design	594
<i>Stelios Giannoulis and Corina Sas</i>	
Wearable Physiological Sensors Reflect Mental Stress State in Office-Like Situations	600
<i>Jacqueline Wijsman, Bernard Grundlehner, Hao Liu, Julien Penders, and Hermie Hermens</i>	
What Really Matters? A Study into People's Instinctive Evaluation Metrics for Continuous Emotion Prediction in Music	606
<i>Vaiva Imbrasaitė, Tadas Baltrušaitis, and Peter Robinson</i>	
When Humans Become Objects: Out-Group Effects in Real and Artificial Faces	612
<i>Aleksandra Swiderska, Eva G. Krumhuber, and Arvid Kappas</i>	
Which Is More Responsible for Boredom in Intelligent Tutoring Systems: Students (Trait) or Problems (State)?	618
<i>William Hawkins, Neil Heffernan, and Ryan S.J.D. Baker</i>	

Main Conference—Doctoral Consortium

Affective Conversational Models: Interpersonal Stance in a Police Interview Context	624
<i>Merijn Bruijnes</i>	
An Automated Framework for Depression Analysis	630
<i>Jyoti Joshi</i>	
Context Based Facial Expression Analysis in the Wild	636
<i>Abhinav Dhall</i>	
Depression Detection & Emotion Classification via Data-Driven Glottal Waveforms	642
<i>David Vandyke</i>	
From Joyous to Clinically Depressed: Mood Detection Using Multimodal Analysis of a Person's Appearance and Speech	648
<i>Sharifa Alghowinem</i>	
Identifying Task Engagement: Towards Personalised Interactions with Educational Robots	655
<i>Lee J. Corrigan, Christopher Peters, and Ginevra Castellano</i>	
Measuring Affect for the Study and Enhancement of Co-present Creative Collaboration	659
<i>Evan Morgan, Hatice Gunes, and Nick Bryan-Kinns</i>	
Speaker Recognition and Speaker Characterization over Landline, VoIP and Wireless Channels	665
<i>Laura Fernández Gallardo</i>	
Stress Recognition Using Wearable Sensors and Mobile Phones	671
<i>Akane Sano and Rosalind W. Picard</i>	
Toward a Computational Model of Social Relations for Artificial Companions	677
<i>Florian Pecune</i>	
Towards a Virtual Teammate Whose Support Can Help Alleviate Stress in the Prehospital Care Domain	683
<i>Peter Kindness</i>	
Towards an Autonomous Theatrical Robot	689
<i>Julián M. Angel Fernandez and Andrea Bonarini</i>	
Towards Automatic and Unobtrusive Recognition of Primary-Process Emotions in Body Postures	695
<i>Marko Radeta and Marco Maiocchi</i>	

Main Conference—Demo and Interactive Events

Affective Touch at a Distance	701
<i>Gijs Huisman, Aduén Darriba Frederiks, and Dirk Heylen</i>	
Automated Coach to Practice Conversations	703
<i>Mohammed (Ehsan) Hoque and Rosalind W. Picard</i>	
Automatic Staging of Audio with Emotions	705
<i>Lakshmi Saheer and Milos Cernak</i>	
EEG-Enabled Affective Applications	707
<i>Olga Sourina and Yisi Liu</i>	
Gtrace: General Trace Program Compatible with EmotionML	709
<i>Roddy Cowie, Martin Sawey, Cian Doherty, Javier Jaimovich, Cavan Fyans, and Paul Stapleton</i>	
Herme, Yet Another Interactive Conversational Robot	711
<i>JinGuang Han, Emer Gilmartin, and Nick Campbell</i>	
On the Fly User's Emotion Capture	713
<i>Philippe Guillotel, Julien Fleureau, Izabela Orlac, and Fernando Silveira</i>	
Sport and Technology: The Case of Archery	715
<i>Cédric Bormand, Angelika Gusewell, Enrico Staderini, and Jagdish Patra</i>	
Ubiquitous Interaction for Computer Mediated Communication of Emotions	717
<i>Maurizio Caon, Omar Abou Khaled, Elena Mugellini, Denis Lalanne, and Leonardo Angelini</i>	
User Modelling and Adaptive, Natural Interaction for Conflict Resolution	719
<i>Kostas Karpouzis, Georgios Yannakakis, Ana Paiva, Jeppe Herlev Nielsen, Asimina Vasalou, and Arnav Jhala</i>	
Video Visualization of Predictors of Emotions Dynamically Expressed by Music	722
<i>Olivier Lartillot, Kim Eliard, Donato Cereghetti, and Didier Grandjean</i>	
Multimodal Affect Recognition in Virtual Worlds: Avatars Mirroring User's Affect	724
<i>Javier Gonzalez-Sanchez, Maria Elena Chavez-Echeagaray, David Gibson, and Robert Atkinson</i>	
Mood Conductor: Emotion-Driven Interactive Music Performance	726
<i>György Fazekas, Mathieu Barthelet, and Mark B. Sandler</i>	

Fifth International Workshop on Affective Interaction in Natural Environments (AFFINE 2013)

Fifth International Workshop on Affective Interaction in Natural Environments (AFFINE 2013): Interacting with Affective Artefacts in the Wild	727
<i>Ginevra Castellano, Kostas Karpouzis, Jean-Claude Martin, Louis-Philippe Morency, Christopher Peters, and Laurel D. Riek</i>	
Constraining Content in Mediated Unstructured Social Interactions: Studies in the Wild	728
<i>James Kennedy, Paul Baxter, and Tony Belpaeme</i>	
Determining the Smallest Emotional Unit for Level of Arousal Classification	734
<i>Bogdan Vlasenko and Andreas Wendemuth</i>	
Learner Modelling and Automatic Engagement Recognition with Robotic Tutors	740
<i>Fotios Papadopoulos, Lee J. Corrigan, Aidan Jones, and Ginevra Castellano</i>	
Shopmobia: An Emotion-Based Shop Rating System	745
<i>Nouf Alajmi, Eiman Kanjo, Nour El Mawass, and Alan Chamberlain</i>	
The Emotracker: Visualizing Contents, Gaze and Emotions at a Glance	751
<i>Isabelle Hupont, Sandra Baldassarri, Eva Cerezo, and Rafael Del-Hoyo</i>	
Towards Automated Full Body Detection of Laughter Driven by Human Expert Annotation	757
<i>Maurizio Mancini, Jennifer Hofmann, Tracey Platt, Gualtiero Volpe, Giovanna Varni, Donald Glowinski, Willibald Ruch, and Antonio Camurri</i>	
Towards Effective Emotional Support for Community First Responders Experiencing Stress	763
<i>Matt Dennis, Peter Kindness, Judith Masthoff, Chris Mellish, and Kirsten Smith</i>	

International Workshop on Mediated Touch and Affect (MeTA 2013)

International Workshop on Mediated Touch and Affect (MeTA 2013): Introduction	769
<i>Gijs Huisman, Nadia Bianchi-Berthouze, and Dirk Heylen</i>	
An Embodiment Perspective of Affective Touch Behaviour in Experiencing Digital Textiles	770
<i>Bruna Petreca, Nadia Bianchi-Berthouze, Sharon Baurley, Penelope Watkins, and Douglas Atkinson</i>	
How to Collect Haptic Expressions of Spontaneous Emotions? Methodological Considerations	776
<i>Gaffary Yoren, Martin Jean-Claude, and Ammi Mehdi</i>	

How to Touch Humans: Guidelines for Social Agents and Robots That Can Touch	780
<i>Jan B.F. Van Erp and Alexander Toet</i>	
Reach Out and Touch Somebody's Virtual Hand: Affectively Connected through Mediated Touch	786
<i>A. Toet, J.B.F. van Erp, F.F. Petrucci, M.H. Dufresnes, A. Sadhashivan, D. Van Alphen, F. Boeree, H.O. de Grijter, J. Hoeksema, C.T. Stamhuis, and P.J. Steenbergen</i>	
Touched by the Storyteller: The Influence of Remote Touch in the Context of Storytelling	792
<i>Merel M. Jung, Robert W.M. Boensma, Gijs Huisman, and Betsy van Dijk</i>	
Virtual Touch Sensations in an Online Shopping Context: An Experimental Approach	798
<i>Suzanne Overmars and Karolien Poels</i>	

Second International Workshop on Context Based Affect Recognition (CBAR 2013)

Towards Context Based Affective Computing	802
<i>Zakia Hammal and Merlin Teodosia Suarez</i>	
Annotation and Classification of Changes of Involvement in Group Conversation	803
<i>Ronald Böck, Stefan Glüge, Ingo Siegert, Andreas Wendemuth, and Stefan Glüge</i>	
Estimation of Attentiveness of People Watching TV Based on Their Emotional Behaviors	809
<i>Masaki Takahashi, Masahide Naemura, Mahito Fujii, and Shin'ichi Satoh</i>	
Vocal and Facial Imitation of Humans Interacting with Virtual Agents	815
<i>Ruud Mattheij, Marie Nilsonova, and Eric Postma</i>	

Third Workshop on Affective Brain-Computer Interfaces (ABCI 2013)

Third Workshop on Affective Brain-Computer Interfaces (ABCI 2013):	
Introduction	821
<i>Christian Mühl, Guillaume Chanel, Brendan Allison, and Anton Nijholt</i>	
A Comparison of Evaluation Measures for Emotion Recognition in Dimensional Space	822
<i>Robert Jenke, Angelika Peer, and Martin Buss</i>	
Affective Brain-Computer Interfaces for Arts	827
<i>Hayrettin Gürkök and Anton Nijholt</i>	

Continuous Recognition of Affective States by Functional Near Infrared Spectroscopy Signals	832
<i>Dominic Heger, Reinhard Mutter, Christian Herff, Felix Putze, and Tanja Schultz</i>	
Development of a Binary fMRI-BCI for Alzheimer Patients: A Semantic Conditioning Paradigm Using Affective Unconditioned Stimuli	838
<i>Giulia Liberati, Ralf Veit, Sunjung Kim, Niels Birbaumer, Christine von Arnim, Anne Jenner, Dorothée Lulé, Albert Christian Ludolph, Antonino Raffone, Marta Olivetti Belardinelli, Josué Dalboni da Rocha, and Ranganatha Sitaram</i>	
EEG-Based Emotion-Adaptive Advertising	843
<i>Yisi Liu, Olga Sourina, and Mohammad Rizqi Hafiyandi</i>	
Emotion Detection from QRS Complex of ECG Signals Using Hurst Exponent for Different Age Groups	849
<i>S. Jerritta, M. Murugappan, Khairunizam Wan, and Sazali Yaacob</i>	
Emotion Recognition from EEG during Self-Paced Emotional Imagery	855
<i>Christian Andreas Kothe, Scott Makeig, and Julie Anne Onton</i>	
Emotional Influence on SSVEP Based BCI	859
<i>Yachen Zhu, Xilan Tian, Guobing Wu, Gilles Gasso, Shangfei Wang, and Stéphane Canu</i>	
Phase-Amplitude Coupling between EEG and EDA While Experiencing Multimedia Content	865
<i>Eleni Kroupi, Jean-Marc Vesin, and Touradj Ebrahimi</i>	
Towards an Affective Brain-Computer Interface Monitoring Musical Engagement	871
<i>Grace Leslie, Alejandro Ojeda, and Scott Makeig</i>	
Using Cross-Task Classification for Classifying Workload Levels in Complex Learning Tasks	876
<i>Carina Walter, Stephanie Schmidt, Wolfgang Rosenstiel, Peter Gerjets, and Martin Bogdan</i>	
Author Index	882

Development of a Binary fMRI-BCI for Alzheimer Patients

A semantic conditioning paradigm using affective unconditioned stimuli

Giulia Liberati

Psychological Sciences Research Institute
Université catholique de Louvain
Louvain la Neuve, Belgium
giulia.liberati@uclouvain.be

Ralf Veit, Sunjung Kim, Niels Birbaumer
Institute of Medical Psychology and Behavioral
Neurobiology
Eberhard-Karls-Universität
Tübingen, Germany

Christine von Arnim, Anne Jenner, Dorothee Lulé,
Albert Christian Ludolph
Department of Neurology
Ulm University
Ulm, Germany

Antonino Raffone, Marta Olivetti Belardinelli
Department of Psychology
Faculty of Medicine and Psychology
Sapienza University
Rome, Italy

Josué Dalboni da Rocha, Ranganatha Sitaram
Department of Biomedical Engineering
University of Florida
Gainesville, USA

Abstract— With the aim of developing a brain-computer interface for the communication of basic mental states, a classical conditioning paradigm with affective stimuli was used, assessing the possibility to discriminate between affirmative and negative thinking in an fMRI-BCI setting. 6 Alzheimer patients and 7 healthy control subjects participated to the study. Congruent and incongruent word-pairs were respectively associated to pleasant (baby laughter) and unpleasant (scream) affective stimuli. A Support Vector Machine classifier focusing on insula, amygdala and anterior cingulate cortex was used to discriminate between the activations relative to congruent and incongruent word-pairs (eliciting respectively affirmative and negative thinking), following the conditioning process. Classification accuracy was on average 70% for Alzheimer patients, reaching 85%, and on average 69% for control subjects, reaching 83%. This study shows that it is possible to extract information on individuals' mental states by exploiting affective responses, overcoming the typical obstacles of traditional BCIs, which generally require time-consuming trainings and intact cognition.

Keywords—Affective BCI; Alzheimer; Classical conditioning; Support Vector Machine

I. INTRODUCTION

Communication deficits can be pervasive in Alzheimer's disease (AD). In the most advanced stages of the neuropathology, patients may be left with the ability to utter only few words, or regress to mutism [1-3]. Despite the

remarkable difficulty in oral communication, patients may still seek social contact [4].

AD patients who have lost the ability to communicate verbally may benefit from a brain-computer interface (BCI) that could allow them to convey basic thoughts and emotions. So far, there has been lack of research in this direction, since BCIs are traditionally considered to require an intact cognitive system to function as a communication method. Moreover, most BCI systems require users' active participation and long trainings to learn to self-regulate their own brain activity.

It has been recently proposed that not only self-regulated brain signals, but also signals that are independent from users' effort, could provide useful information related to users' mental states. The recently introduced 'affective BCIs', by relying on emotions, do not require users to actively perform a cognitive task [5]. Such interfaces could be particularly useful for individuals with cognitive impairment, such as mental retardation or dementia.

Given that BCIs based on operant conditioning are generally problematic for cognitively impaired individuals, we performed a paradigm shift to classical conditioning, using affective stimuli as unconditioned stimuli (US) and simple word-pairs as conditioned stimuli (CS). Using affective stimuli is particularly convenient because affectivity is generally preserved in the course of dementia [6]. More specifically, we assessed the feasibility of an auditory classical conditioning paradigm within an fMRI-based BCI setting,

designed to condition AD patients to associate negative and positive affective sounds with incongruent and congruent word-pairs. We decided to use auditory stimulation since it has been shown that although AD patients differ significantly from healthy subjects in emotional processing of visual stimuli, there are no consistent differences in processing emotions through the auditory domain [7].

Our main goal was to ascertain whether the brain activations relative to congruent and incongruent word-pairs, respectively eliciting affirmative (“yes”) and negative (“no”) responses, could be classified using a linear Support Vector Machine (SVM) after the conditioning process. The possibility to discriminate positive and negative emotional states using a SVM was already demonstrated by Sitaram and colleagues [8]. We hypothesized that the differentiation between affirmative and negative responses would be evident, following the conditioning with affective stimuli, in brain regions that are mostly involved in emotional processing, such as insula, amygdala and anterior cingulate cortex (ACC) [9].

II. METHODS

A. Participants

6 AD patients recruited at the Memory Clinic of Ulm (2 males, 4 females, age: 69-91, average Mini Mental State Examination score: 22.5), and 7 healthy controls (5 males, 2 females, age 62-83), all native German speakers, participated to the study. All participants gave written informed consent prior to participation to the fMRI experiment. The study was approved by the Ethics Committee of the University of Ulm and was performed in compliance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

B. Stimuli

Stimuli consisted of 300 German word-pairs, half congruent (e.g. “Tier-Katze”, “Animal-Cat”) and half incongruent (e.g. “Tier-Apfel”, ”Animal-Apple”), recorded using a SpeedLink USB microphone and QuickTime Player 7 program for Macintosh. Word-pairs included very simple terms belonging to common categories (such as animals or fruit), so that the recognition of their congruence or incongruence take place, at least implicitly, in mild AD patients [10-14]. Each word-pair lasted 1.5 s. The negative and affirmative responses to the word-pairs constituted the conditioned stimuli (CS). The unconditioned stimuli (US) were two standardized emotional sounds drawn from the International Affective Digitized Sounds (IADS, [15]): a pleasant emotional stimulus (a baby-laughter) and an unpleasant emotional stimulus (a scream). The duration of each US was also 1.5 s. To ascertain that all stimuli had the same precise length, their duration was adjusted using the software program Audacity 1.3.14 Beta for Mac OS X. Stimuli presentation in the fMRI scanner was performed with a software interface developed in Matlab v. 6.5 (Mathworks, Inc., Sherbon, MA). Participants heard all auditory stimuli

through MRI-compatible headphones with efficient gradient noise suppression (up to 45 dB).

C. Experimental paradigm

The paradigm consisted of a single session divided into three blocks (Fig 1). In the first block, congruent (CS1) and incongruent (CS2) word-pairs were presented aurally, immediately followed by an affective pleasant (baby-laughter, US1) or unpleasant (scream, US2) sound, respectively. In the second and third blocks, only half of the word-pairs were followed by affective stimulation. While the first block was necessary to associate affirmative and negative thinking to positive and negative emotions, the remaining blocks served to verify the possibility to discriminate between affirmative and negative thinking when the affective stimulation was not present anymore.

Participants were simply instructed to listen to the word-pairs, and to think ‘yes’ if a word-pair was congruent, ‘no’ if it was incongruent.

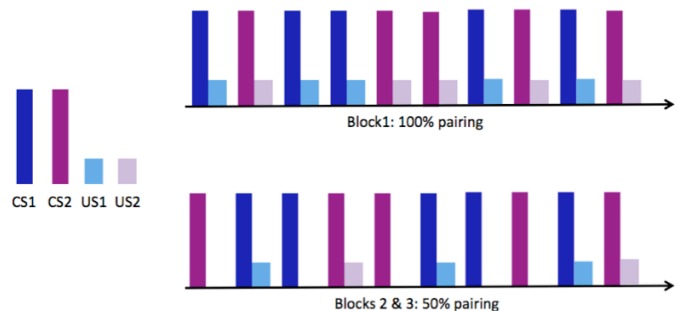


Fig. 1. In the first block incongruent and congruent word-pairs (CS1, CS2) were always followed by a pleasant or unpleasant affective stimulus (US1, US2), in order to associate negative and affirmative thinking to negative and positive emotions respectively. In the second and third blocks, only 50% of the word-pairs were followed by affective stimuli, to verify the possibility to discriminate between the activation elicited by affirmative and negative thinking when affective stimulation was no more present.

D. fMRI data acquisition

The measurements took place in a 3.0 Tesla body scanner, with standard 12-channels head coil (Siemens Magnetom Tim TRIO, Siemens, Erlangen, Germany). A standard echo-planar imaging sequence was used (EPI; TR = 1.5 s, matrix size = 64×64, TE = 30 ms, flip angle = 70°). Sixteen oblique slices (voxel size = 3.3 times; 3.3×5.0 mm³, slice gap = 1 mm), AC/PC aligned in axial orientation were acquired. For superposition of functional maps upon brain anatomy, a high-resolution T1-weighted structural scan of the whole brain was collected from each participant (MPRAGE, matrix size = 256 times; 256, 160 partitions, 1 mm³ isotropic voxels, TR = 2300 ms, TE = 3.93 ms, TI = 1100 ms, flip angle = 8°). The first 10 volumes of every block were discarded to permit T1 equilibrium.

E. fMRI data analysis

Data were pre-processed using Statistical Parametric Mapping (SPM8, Wellcome Department of Imaging Neuroscience, London, UK) run on Matlab R2008b (Mathworks, Inc., Sherborn, MA, USA). Images of each participant were normalized to a standard Echo-Planar Imaging (EPI) template in Montreal Neurological Institute (MNI) space. Prior to statistical analyses, data were high-pass (cutoff 128 s) and low-pass (AR(1)) filtered.

We performed a classification analysis using a linear SVM by selecting the fMRI signals from each voxel within insula, ACC and amygdala as input vector. Signals corresponding to various conditions, namely, congruent and incongruent word-pairs from the late acquisition and extinction phases were classified. A ‘searchlight approach’ [16] was adopted, employing a cubic searchlight algorithm (3x3x3 cube) which moved over each voxel of the insula, ACC and amygdala in an incremental sweep. 1000 voxels were selected for feature extraction using a smoothed Fisher Score. Only the fourth and the fifth volumes after the presentation of the word-pairs were considered, based on the empirical observation that such time points produced the highest differences between conditions. Subsequently, the features were submitted to the SVM, which operated using a linear kernel function. Classification accuracy was computed by averaging the classification accuracies from 35 replications of a leave-one-out cross validation principle.

III. RESULTS

Table 1 and Table 2 show the individual classification accuracies, sensitivities and specificities relatively to the second and third blocks (when the affective stimulation was not present anymore). Offline classification accuracies for AD patients reached up to 85%, with an average of 71%. Offline classification accuracies for healthy controls reached up to 83%, with an average of 69%.

TABLE I.

	Accuracy	Sensitivity	Specificity
Patient 1	0.70	0.70	0.70
Patient 2	0.53	0.50	0.55
Patient 3	0.78	0.70	0.85
Patient 4	0.63	0.55	0.70
Patient 5	0.85	0.80	0.90
Patient 6	0.75	0.80	0.70
Average	0.71	0.68	0.73

^a. Offline classification results of the unpaired word-pairs in blocks 2 and 3 for Alzheimer patients.

TABLE II.

	Accuracy	Sensitivity	Specificity
Control 1	0.70	0.70	0.70
Control 2	0.63	0.65	0.60
Control 3	0.63	0.60	0.65
Control 4	0.58	0.55	0.60
Control 5	0.78	0.80	0.75
Control 6	0.83	0.85	0.80
Control 7	0.68	0.70	0.65
Average	0.69	0.69	0.68

^c. Offline classification results of the unpaired word-pairs in blocks 2 and 3 for control subjects

IV. DISCUSSION

We assessed a novel affective-BCI approach using classical conditioning with emotional stimuli in combination with brain state classification. The paradigm allowed to extract information on the participants’ mental states, namely affirmative and negative thinking, by exploiting affective responses. AD patients and healthy controls comparably responded to the conditioning process, showing that responses related to congruent and incongruent word-pairs could be discriminated after associating them to pleasant and unpleasant affective stimuli. The study shows that the typical hindrances of standard BCIs, which generally require time-consuming trainings and an active effort of the user in order to learn to self-regulate brain signals, can be overcome thanks to the use of affective stimuli.

In order to develop an affective BCI, some points need to be taken into consideration. Firstly, although useful for the identification of very specific cortical and subcortical brain regions, fMRI is not a system that could be used in everyday life. More portable systems, such as near-infrared spectroscopy based BCIs (NIRS-BCISs) [17] could be adopted for online classification of mental states. Secondly, it is possible that the conditioning effect extinguishes very quickly, meaning that several acquisition sessions could be necessary for its maintenance.

In our study only mildly affected AD patients were considered. However, patients at different stages of the disease may have different acquisition and extinction timings. These differences could be exploited for diagnostic aims, for instance by measuring the conditioned response in subjects with mild cognitive impairment who have not yet developed dementia. Testing with patients affected by other kinds of dementia (e.g. frontotemporal dementia) could also be used for differential diagnosis. Moreover, affective BCIs could open up new opportunities for cognitive rehabilitation.

ACKNOWLEDGMENT

We are very grateful to Adelheid Kumpf for helping in the preparation of the stimuli and to Sonja Fuchs for her support during the fMRI measurements.

REFERENCES

- [1] R. Au, M.L. Albert and L.K. Obler, "The relation of aphasia to dementia", *Aphasiology*, vol. 2, 1988, p. 161-173.
- [2] E. Miller, "Language impairment in Alzheimer type dementia", *Clinical Psychology Review*, vol. 9, 1989, p. 181-195.
- [3] V. Taler and N.A. Phillips, "Language performance in Alzheimer's disease and mild cognitive impairment: a comparative review", *Journal of Clinical and Experimental Neuropsychology*, vol. 30, Jul. 2008, p. 501-56.
- [4] P.A. Mayhew, G.J. Acton, S. Yauk and B.A. Hopkins, "Communication from individuals with advanced DAT: can it provide clues to their sense of self-awareness and well-being?", *Geriatric Nursing*, vol. 22, 2001, p. 106-10.
- [5] F. Nijboer, U. Hoffmann, F. Morin, S. Carmien, E. Leon and R. Koene, "Affective Brain-Computer Interfaces: Psychophysiological Markers of Emotion in Healthy Persons and in Persons with Amyotrophic Lateral Sclerosis", *Workshop on affective brain-computer interfaces & IEEE international workshop on social signal processing ABCI*, vol. 2, 2009, p. 1-11.
- [6] D. Zaitchik, E. Koff, H. Brownell, E. Winner and M. Albert, "Inference of beliefs and emotions in patients with Alzheimer's disease", *Neuropsychology*, vol. 20, Jan. 2006, p. 11-20.
- [7] E. Koff, D. Zaitchik, J. Montepare and M.S. Albert, "Emotion processing in the visual and auditory domains by patients with Alzheimer's disease", *J Int Neuropsychol Soc*, vol. 5, Jan. 1999, p. 32-40.
- [8] R. Sitaram, S. Lee, S. Ruiz, M. Rana, R. Veit and N. Birbaumer, "Real-time support vector classification and feedback of multiple emotional brain states", *Neuroimage*, vol. 56, May 2011, p. 753-65.
- [9] K.L. Phan, T. Wager, S.F. Taylor and I. Liberzon, "Functional neuroanatomy of emotion: a meta-analysis of emotion activation studies in PET and fMRI", *Neuroimage*, vol. 16, Jun. 2002, p. 331-48.
- [10] M. Hartman, "The use of semantic knowledge in Alzheimer's disease: evidence for impairments of attention", *Neuropsychologia*, vol. 29, 1991, p. 213-28.
- [11] M. Laisney, B. Giffard, S. Belliard, V. de la Sayette, B. Desgranges and F. Eustache, "When the zebra loses its stripes: Semantic priming in early Alzheimer's disease and semantic dementia", *Cortex*, vol. 47, Jan. 2011, p. 35-46.
- [12] R.D. Nebes, "Contextual facilitation of lexical processing in Alzheimer's disease: intralexical priming or sentence-level priming?", *Journal of Clinical and Experimental Neuropsychology*, vol. 16, Aug. 1994, p. 489-97.
- [13] Alzheimer's disease", *Neuropsychologia*, vol. 26, 1988, p. 273-286.
- [14] S.L. Rogers and R.B. Friedman, "The underlying mechanisms of semantic memory loss in Alzheimer's disease and semantic dementia", *Neuropsychologia*, vol. 46, Jan. 2008, p. 12-21.
- [15] M.M. Bradley and P.J. Lang, International Affective Digitized Sounds (IADS): Stimuli, instruction manual and affective ratings, Gainesville: University of Florida, 1999.
- [16] N. Kriegeskorte, R. Goebel and P. Bandettini, "Information-based functional-brain mapping", *Proceedings of the National Academy of Sciences USA*, vol. 103, 2006, p. 3863-3868.
- [17] R. Sitaram, H. Zhang, C. Guan, M. Thulasidas, Y. Hoshi, A. Ishikawa, K. Shimizu and N. Birbaumer, "Temporal classification of multichannel near-infrared spectroscopy signals of motor imagery for developing a brain-computer interface", *Neuroimage*, vol. 34, Feb. 2007, p. 1416-27.

IEEE Computer Society Technical & Conference Activities Board

T&C Board Vice President

Paul R. Croll

Computer Sciences Corporation

IEEE Computer Society Staff

Evan Butterfield, *Director of Products and Services*

Lynne Harris, *CMP, Senior Manager, Conference Support Services*

Alicia Stickley, *Senior Manager, Publishing Operations*

Silvia Ceballos, *Manager, Conference Publishing Services*

Patrick Kellenberger, *Supervisor, Conference Publishing Services*

IEEE Computer Society Publications

The world-renowned IEEE Computer Society publishes, promotes, and distributes a wide variety of authoritative computer science and engineering texts. These books are available from most retail outlets. Visit the CS Store at <http://www.computer.org/portal/site/store/index.jsp> for a list of products.

IEEE Computer Society *Conference Publishing Services* (CPS)

The IEEE Computer Society produces conference publications for more than 300 acclaimed international conferences each year in a variety of formats, including books, CD-ROMs, USB Drives, and on-line publications. For information about the IEEE Computer Society's *Conference Publishing Services* (CPS), please e-mail: cps@computer.org or telephone +1-714-821-8380. Fax +1-714-761-1784. Additional information about *Conference Publishing Services* (CPS) can be accessed from our web site at: <http://www.computer.org/cps>

Revised: 18 January 2012



CPS Online is our innovative online collaborative conference publishing system designed to speed the delivery of price quotations and provide conferences with real-time access to all of a project's publication materials during production, including the final papers. The **CPS Online** workspace gives a conference the opportunity to upload files through any Web browser, check status and scheduling on their project, make changes to the Table of Contents and Front Matter, approve editorial changes and proofs, and communicate with their CPS editor through discussion forums, chat tools, commenting tools and e-mail.

The following is the URL link to the **CPS Online** Publishing Inquiry Form:

<http://www.computer.org/portal/web/cscps/quote>