

Lecture Notes in Artificial Intelligence 6867

Subseries of Lecture Notes in Computer Science

LNAI Series Editors

Randy Goebel

University of Alberta, Edmonton, Canada

Yuzuru Tanaka

Hokkaido University, Sapporo, Japan

Wolfgang Wahlster

DFKI and Saarland University, Saarbrücken, Germany

LNAI Founding Series Editor

Joerg Siekmann

DFKI and Saarland University, Saarbrücken, Germany

Vladimír Mařík
Pavel Vrba
Paulo Leitão (Eds.)

Holonic and Multi-Agent Systems for Manufacturing

5th International Conference on Industrial Applications
of Holonic and Multi-Agent Systems, HoloMAS 2011
Toulouse, France, August 29-31, 2011
Proceedings

Series Editors

Randy Goebel, University of Alberta, Edmonton, Canada
Jörg Siekmann, University of Saarland, Saarbrücken, Germany
Wolfgang Wahlster, DFKI and University of Saarland, Saarbrücken, Germany

Volume Editors

Vladimír Mařík
Czech Technical University, Faculty of Electrical Engineering
Department of Cybernetics
16627 Prague 6, Czech Republic
E-mail: marik@labe.felk.cvut.cz

Pavel Vrba
Rockwell Automation Research Center
Pekařská 10a/695, 15500 Prague 5, Czech Republic
E-mail: pvrba@ra.rockwell.com

Paulo Leitão
Polytechnic Institute of Bragança
Campus Sta Apolonia, Apartado 1134, 5301-857 Bragança, Portugal
and Artificial Intelligence and Computer Science Laboratory
R. Campo Alegre 102, 4169-007 Porto, Portugal
E-mail: pleitao@ipb.pt

ISSN 0302-9743
ISBN 978-3-642-23180-3
DOI 10.1007/978-3-642-23181-0
Springer Heidelberg Dordrecht London New York

e-ISSN 1611-3349
e-ISBN 978-3-642-23181-0

Library of Congress Control Number: 2011934364

CR Subject Classification (1998): I.2.11, J.6, I.6, D.2, D.2.9

LNCS Sublibrary: SL 7 – Artificial Intelligence

© Springer-Verlag Berlin Heidelberg 2011

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Another two years have passed from the last HoloMAS conference held in Linz in 2009. It is a pleasure to say that the R&D activities around holonic and multi-agent systems for industrial applications have not faded during this period. On the contrary, the number of scientific events aimed at the subject field is growing steadily. Besides HoloMAS, which has been the pioneering event in this field, there are multiple conferences such as the IEEE Conference on Industrial Informatics (INDIN), the IEEE Conference on Emergent Technologies and Factory Automation (ETFa) or the IFAC Symposium on Information Control Problems in Manufacturing (INCOM) that aim their attention at advanced industrial automation systems based on intelligent agents.

This year's conference was the eighth in the sequence of HoloMAS events. The first three (HoloMAS 2000 in Greenwich, HoloMAS 2001 in Munich and HoloMAS 2002 in Aix-en-Provence) were organized as workshops under the umbrella of DEXA association. Starting with 2003, HoloMAS became an independent conference organized biyearly on the odd years, still under the DEXA patronage (HoloMAS 2003 in Prague, HoloMAS 2005 in Copenhagen, HoloMAS 2007 in Regensburg and HoloMAS 2009 in Linz). On the even years the attention is focused on specific events: the IEEE Workshop on Distributed Intelligent Systems (DIS 2006) with a special track covering the "obvious" HoloMAS topics was organized in Prague in June 2006. Similarly, the IEEE Conference on Distributed Human-Machine Systems (DHMS 2008), which has absorbed the HoloMAS field, was held in Athens, Greece, in March 2008, and the IFAC Workshop on Intelligent Manufacturing Systems (IMS 2010) in Lisbon, Portugal, in 2010. This approach allows the HoloMAS community to be better integrated with both the information society-oriented DEXA community as well as the IEEE Society aimed at human-machine systems, cybernetics, and industrial informatics.

The research of holonic and agent-based systems receives constant support from both the public sector and private institutions. There is an increased interest from the IEEE System, Man, and Cybernetics (SMC) Society, namely, from its Technical Committee on Distributed Intelligent Systems, which leverages the experience gained in the former Holonic Manufacturing Systems consortium. Another IEEE body - the Industrial Electronics Society - supports the related R&D field through its Technical Committee on Industrial Agents (<http://tcia.ieee-ies.org/>). Its mission is to provide a base for researchers and application practitioners, to share their experiences with applications of holonic and agent technologies in the industrial sector, especially in assembly and process control, planning and scheduling, and supply chain managements. There are number of impacted journals that provide space for articles dealing with industrial agents such as the *IEEE Transactions on SMC, Part C: Applications*

and Reviews, *Journal of Engineering of Artificial Intelligence Applications (EAAI)*, *IEEE Transactions on Industrial Informatics*, *Computers in Industry* or the *Journal of Autonomous Agents and Multi-Agent Systems (JAAMAS)*. Let us recall that the extended versions of selected best HoloMAS 2009 papers were published in the special issue of the *International Journal of Production Research*.

It is our pleasure to inform you that for HoloMAS 2011 there were 36 papers submitted, from which the Program Committee selected 25 papers to be included in this volume, by authors from 13 countries all over the world. Among the key trends that the accepted papers report on is the effort to shift the holonic/agent-based control system from the personal computer (the prevalent hosting platform in the past) closer to the “hardware.” The obvious reason is to increase even more the distributiveness and thus the robustness and flexibility of the control system. In this model the control application is designed as embedded software running on a dedicated microcontroller. This brings new challenges related to limited resources in terms of memory, processing power, battery life, etc. Related topics discussed in this volume are the employment of simulation techniques for modeling, designing and validating the control system prior to its deployment on the real hardware. The boom in Web applications and smart mobile devices like smart phones and tablets have recently drawn the attention of the industrial sector as it brings new challenges and possibilities for building next-generation user interfaces for SCADA and operator panels. Looking at the applications of holonic and agent systems we collected quite an interesting portfolio this year, including smart grids, supply chain and logistics, healthcare, mobile robots and unmanned aerial vehicles.

There were two invited talks specifically targeted toward HoloMAS 2011:

- Peter Skobelev (Magenta Solutions): “Multi-agent Systems for Real-Time Resource Allocation, Scheduling, Optimization and Controlling”
- Alois Zoitl (Vienna University of Technology): “A Control Architecture for Self-Reconfigurable Production Systems”

Also, for the first time in the HoloMAS history, there was a special session organized covering the topic of smart industrial systems.

The HoloMAS 2011 conference was a highly motivating environment, challenging the future research and fostering integration in the subject field. It has always served as a showcase of the holonic and agent-based manufacturing research offering information on the state of the art to specialists in neighboring, knowledge-processing research fields covered by the DEXA multi-conference event. We are very grateful to the DEXA Association for providing us with this excellent opportunity. We would like to express our many thanks to Gabriela Wagner for all her organizational efforts which were of key importance for the success of this event.

We would like to thank the IEEE SMC Society, and especially the Technical Committee on Distributed Intelligent Systems of this Society, for its technical co-sponsorship.

June 2011

Vladimír Mařík
Pavel Vrba
Paulo Leitão

HoloMAS 2011

5th International Conference on Industrial Applications of Holonic and
Multi-agent Systems, HoloMAS 2011

Applications of Holonic and Multi-agent Systems

Toulouse, France, August 29–31, 2011

Program Co-chairs

Vladimír Mařík	Czech Technical University in Prague, Czech Republic
Pavel Vrba	Rockwell Automation, Czech Republic
Paulo Leitão	Polytechnic Institute of Bragança, Portugal

Program Committee

José Barata	Universidade Nova de Lisboa, Portugal
Jean-Paul Barthes	Université de Technologie de Compiègne, France
Vicente Botti	Universidad Politecnica de Valencia, Spain
Robert W. Brennan	University of Calgary, Canada
Birgit Burmeister	Daimler AG, Germany
Luis Camarinha-Matos	Universidade Nova de Lisboa, Portugal
Pierre Castagna	Université de Nantes, France
Armando W. Colombo	Schneider Electric, Germany
Adriana Giret	Universidad Politecnica de Valencia, Spain
Dominic Greenwood	Whitestein Technologies, Switzerland
William Gruver	Simon Fraser University, Canada
Kenwood Hall	Rockwell Automation, USA
Salima Hassas	Université Claude Bernard Lyon 1, France
Toshiya Kaihara	Kobe University, Japan
Kari Koskinen	Helsinki University of Technology, Finland
Jose L.M. Lastra	Tampere University of Technology, Finland
Wilfried Lopuschitz	Vienna University of Technology, Austria
Michael Luck	King's College London, UK
Francisco Maturana	Rockwell Automation, USA
Duncan McFarlane	Cambridge University, UK
Michal Pěchouček	Czech Technical University in Prague, Czech Republic

Milan Rollo	Czech Technical University in Prague, Czech Republic
Martijn Rooker	Profactor, Austria
Stuart Rubin	SPAWAR Systems Center, San Diego, USA
George Rzewski	The Open University, UK
Ilkka Seilonen	Helsinki University of Technology, Finland
Weiming Shen	University of Western Ontario, Canada
Leonid Sheremetov	Mexican Oil Institute, Mexico
Kwang Sim	Gwangju Institute of Science and Technology, Republic of Korea
Alexander Smirnov	SPIIRAS, Russia
Thomas Strasser	AIT, Austria
Paul Valckenaers	Catholic University Leuven, Belgium
Valeriy Vyatkin	University of Auckland, New Zealand
Alois Zoitl	Vienna University of Technology, Austria

External Reviewers

Petr Bečvář	Certicon, Czech Republic
Petr Hejda	Rockwell Automation, Czech Republic
Jiří Hodík	Czech Technical University in Prague, Czech Republic
Michal Jakob	Czech Technical University in Prague, Czech Republic
Lenka Lhotská	Czech Technical University in Prague, Czech Republic
Marek Obitko	Rockwell Automation, Czech Republic
Libor Přeučil	Czech Technical University in Prague, Czech Republic
Pavel Tichý	Rockwell Automation, Czech Republic
Jan Tožička	Czech Technical University in Prague, Czech Republic
Jiří Vokřínek	Czech Technical University in Prague, Czech Republic

Organizing Committee

Petr Benda	Czech Technical University in Prague, Czech Republic
Barbora Jeníková	Czech Technical University in Prague, Czech Republic
Gabriela Wagner	FAW, University of Linz, Austria

Table of Contents

Invited Talk

Multi-Agent Systems for Real Time Resource Allocation, Scheduling, Optimization and Controlling: Industrial Applications	1
<i>Petr Skobelev</i>	

Industrial Agents

Recent Developments and Future Trends of Industrial Agents	15
<i>Paulo Leitão and Pavel Vrba</i>	
An Application of the Holonic Manufacturing System to a Flexible Assembly Cell	29
<i>Olivier Roulet-Dubonnet and Pål Ystgaard</i>	
Using EtherNet/IP with IEC 61499 Communication Function Blocks . . .	39
<i>Wilhelm Leonhardsberger and Alois Zoitl</i>	
A Test and Validation Approach for the Standard-Based Implementation of Intelligent Electronic Devices in Smart Grids	50
<i>Thomas Strasser, Filip Andren, and Matthias Stifter</i>	
Localization of Industrial Wireless Sensor Networks: An Artificial Neural Network Approach	62
<i>Mohammad Gholami and Robert W. Brennan</i>	
New Trends of Visualization in Smart Production Control Systems	72
<i>Pavel Vrba, Petr Kadera, Václav Jirkovský, Marek Obitko, and Vladimír Mařík</i>	
Multi-Agent System for On-demand Production Integrating Production and Quality Control	84
<i>Paulo Leitão and Nelson Rodrigues</i>	
FPGA Framework for Agent Systems Using Dynamic Partial Reconfiguration	94
<i>Edward Chen, Victor Gusev Lesau, Dorian Sabaz, Lesley Shannon, and William A. Gruver</i>	

Simulation and Modelling

Holonic Multi-Agent System for Real Time Simulation of Control Systems	103
<i>Francisco Maturana, Raymond Staron, Dan Carnahan, Asha Iype, and Ken Hall</i>	
Communication- and Computation- Bounded Agents in Multi-agent Simulations	114
<i>Michal Čáp, Jiří Vokřínek, and Antonín Komenda</i>	
Simulation Environment for the Optimization of the Data Retrieval Capabilities of an Agent Based System in a Healthcare Setting	124
<i>José Hilário Patriarca-Almeida, Pedro Manuel Vieira-Marques, and Ricardo João Cruz-Correia</i>	
Artificial Social Models for Holonic Systems	133
<i>Călin Ciufudean and Constantin Filote</i>	

Planning and Scheduling

Multiagent Systems for Production Planning in Automation	143
<i>Francis Martínez, Jose Aguilar, and César Bravo</i>	
Model-Driven Development of Multi-Agent Based Collaborative Planning Concepts for Heterarchical Supply Chains	153
<i>Bernd Hellingrath and Peer Küppers</i>	
Multi-Agent System for Scheduling of Flight Program, Cargo Flow and Resources of International Space Station	165
<i>Anton Ivaschenko, Igor Khamits, Petr Skobelev, and Marina Sychova</i>	
iCoMAS: An Agent-Based System for Cooperative Transportation Planning in the Food Industry	175
<i>Ralf Sprenger and Lars Mönch</i>	

Special Session: Smart Technical Systems

Roles-Based MAS Applied to the Control of Intelligent Products in FMS	185
<i>Cyrille Pach, Gabriel Zambrano, Emmanuel Adam, Thierry Berger, and Damien Trentesaux</i>	
PROSA and Delegate MAS in Robotics	195
<i>Johan Philips, Paul Valckenaers, Erwin Aertbeliën, Jan Van Belle, Bart Saint Germain, Herman Bruyninckx, and Hendrik Van Brussel</i>	
A Goal-Based Approach to Holonic Manufacturing	205
<i>Jacqueline Jarvis, Dennis Jarvis, and Anthony Martin</i>	

Agents Tasks Reallocation for Collaborative Urban Supply Chain Management	215
<i>Emmanuel Adam, Gael Hette, Sylvia Estivie, Asma Melki, and Rene Mandiau</i>	
MAS for Unmanned Aerial Vehicles	
Ground Tactical Mission Support by Multi-agent Control of UAV Operations	225
<i>Jiří Vokřínek, Peter Novák, and Antonín Komenda</i>	
Surveillance of Unmanned Aerial Vehicles Using Probability Collectives	235
<i>Přemysl Volf, David Šišlák, Dušan Pavlíček, and Michal Pěchouček</i>	
Towards Cooperation in Adversarial Search with Confidentiality	246
<i>Branislav Bošanský, Viliam Lisý, and Michal Pěchouček</i>	
Dynamic Trajectory Replanning for Unmanned Aircrafts Supporting Tactical Missions in Urban Environments	256
<i>Lukáš Chrupa and Peter Novák</i>	
Author Index	267