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Preface to the Special Issue on "Uncertainty-based Technologies for Ambient Intelligence Systems"

Ambient Intelligence (AmI) worlds offer exciting potential for rich interactive experiences. The metaphor of AmI envisages the future as intelligent environments where humans are surrounded by smart devices that makes the ambient itself sensitive and responsive to humans' needs or wishes. Researchers predict that AmI will be densely populated by IT gadgets and systems with powerful capabilities. Humans cohabiting in AmI spaces exploit invisible as well as high dimensional graphical environments for entertainment, education, working, more in general living. AmI modifies not only the sense of being there but also the experience and capability to interact with real or virtual objects by using appropriate media facilitators. The way we can provide the right communication channel is strongly dependent by the quality of the symbolic representation in which humans, sensors and actuators are involved. The scope of this special issue is to give to the reader a wide scenario of recent works characterized by a synergistic combination of Computational Intelligence (CI) and Ambient Intelligence. AmI is thus a multi-disciplinary research field where several areas are merged, including CI and AmI. CI inside Agents is extremely helpful to support the designer of AmI systems in treating with unknown or ill-defined environments so to better handle knowledge representation and reasoning under these assumptions. The six papers cover aspects of both the development and the usage and organizational implementation of AmI systems.

The first paper is written by Javad Akhlaghinia, Ahmad Lotfi, Caroline Langensiepen and Nasser Sherkat. It presents an occupant behaviour prediction technique for an ambient intelligence computing environment. The proposed technique has proven to be very practical for single occupant environment. The project aim is to deliver a wellbeing monitoring and assistive environment to support elderly lives independently and the assumption of single occupancy is not far from reality. In this paper, the reader can find a comprehensive comparative study on different approaches available in predictive techniques in prediction of occupant behaviour focusing mainly in three areas of data mining, soft computing techniques and statistical modelling prediction techniques. The research result discussed by the authors is focused on the proposal of an Evolving Fuzzy Predictor (EFP) model suitable to predict the combined occupancy time series.

The second paper is written by Anastasios Dounis, and Christos Caraiscos. This work is framed on a study for the development of building intelligent management systems (BIEMS), mainly for big buildings like offices, hotels, and commercial buildings. The main objectives of their work are: i) to demonstrate the uncertainties related to the concept of comfort; ii) to determine the discrete comfort fuzzy set in fuzzy cube and define the membership grade using fuzzy equality measure; iii) to pursue the systematic development of intelligent coordinator; iv) to test the IC in the environmental conditions control in buildings. A key issue is played by an intelligent coordinator agent. It consists of a master agent and a slave agent that are both implemented by fuzzy logic theory. Master agent evaluates the energy efficiency of the building and comfort of occupants. A fuzzy inference mechanism produces signals that activate the slave agent and change the set points of the controllers. The slave agent is a fuzzy negotiation machine (FNM), which synchronizes the interaction of the FCAs and manages to avoid conflicts between them

The third paper is written by Vincenzo Galdi, Vincenzo Loia, Antonio Piccolo, and Veniero Mario. The purpose of this paper is to present an innovative system aiming at monitoring and steering vehicular flows nearby tunnels with high accidents risk rate. Based on the integration of IC, video, agent and soft computing technologies, the system's mission is to reduce the risk of accidents which occur inside tunnel through the adaptive generation of speed limits and information to the users approximating tunnels. Strict real-time requirements of the applicative context impose our goal being achieved through a parallel Hierarchical Fuzzy Controller (HFC) implemented by means of a Fuzzy Control Agents Network (FCAN) allowing the system to gain higher performances.

The fourth paper is written by Donatella Guarino and Alessandro Saffiotti. In their contribution, the authors face the complex problem of interfacing with an ubiquitous domestic system. In particular, this paper addresses a specific, important case of this interface problem: to enable the everyday user of the ubiquitous (AmI or robotic) system to monitor the state of the system. Fuzzy Logic plays a fundamental role: the authors use fuzzy logic techniques to represent status information, and fuzzy propositional calculus to combine individual items of status information into a summary one. Even though their approach is in principle applicable to any heterogeneous distributed system, the authors present a concrete utilization of a specific system for ubiquitous robotics, named Ecology of Physically Embedded Intelligent Systems, or *Peis-Ecology*.

The fifth paper is written by Hakan Duman, Hani Hagras, and Vic Callaghan. In this work the authors present a novel fuzzy based intelligent method that is based on a function/semantic-free exploration algorithm to find and learn the most relevant associations between various devices and services operating in an Ambient Intelligent Environment. The proposed approach employs fuzzy-based embedded agents due to their robustness to the uncertainties, noise and imprecision attributed to real world systems as in Ambient Intelligent Environments. The embedded agents seek to reduce the number of associations to other devices to minimize both the communication and computational processing latencies generated by the redundantly interconnected devices while satisfying the AIE and the user's personalized needs. The proposed approach has been tested and verified in the Essex intelligent Dormitory (iDorm) which is a well known test bed for Ambient Intelligence research.

The last paper is by Jafreezal Jaafar and Eric McKenzie. The authors focus on the Action Selection Problem (ASP), one of the fundamental problems for any autonomous system whose Action Selection Mechanism (ASM) capability assures the selection of the "best" action to execute using the internal and the external perceptions on the environment. It is hard to make good decisions that satisfy both goal and constraint, especially when sensory data matches with several behaviour rules (conditional part of the rules), such that more than one behaviour rule is fired at the same time. As a result, behaviour rules conflict with one another, which means that more than one rule becomes active at one time. The authors solve this problem by means of a behaviour-based fuzzy controller and local minima algorithm In this work a new fuzzy method for the action selection problem is presented, detailing how this approach is based on fuzzy-levels incorporated with the Huwicz criterion.

As mentioned these contributions cover both development issues, aspects regarding the implementation and reflections on methodological issues, with particular emphasis on uncertain processing. Even though it is not simple to draw precise conclusions and trends across the papers presented in this special issue, there is no doubt on the fundamental role played by Computational Intelligence techniques combined with Agent paradigm. The papers herein presented elaborate and refine many important issues arising from this intersection, and as guest editors I believe this issue gives a further enhancement in this direction.

I would like to take the opportunity to thank all authors who submitted papers for the special issue as well as the anonymous reviewers, without their appreciated effort it would have been impossible to produce this special issue.

We hope the reader will enjoy the results of these efforts.

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