Advances in Intelligent Systems and Computing 291

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Paulo Novais
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Ambient Intelligence - Software and Applications

5th International Symposium on Ambient Intelligence

Springer

Advances in Intelligent Systems and Computing

Volume 291

Series editor

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ISSN 2194-5357 ISSN 2194-5365 (electronic)
ISBN 978-3-319-07595-2 ISBN 978-3-319-07596-9 (eBook)
DOI 10.1007/978-3-319-07596-9
Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014939995

Printed on acid-free paper

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

Preface

This volume contains the proceedings of the 5^{th} International Symposium on Ambient Intelligence (ISAmI 2014). The Symposium was held in Salamanca, Spain on June 4^{th}-6^{th} at the University of Salamanca, under the auspices of the Bioinformatic, Intelligent System and Educational Technology Research Group (http://bisite.usal.es/) of the University of Salamanca.

ISAmI has been running annually and aiming to bring together researchers from various disciplines that constitute the scientific field of Ambient Intelligence to present and discuss the latest results, new ideas, projects and lessons learned, namely in terms of software and applications, and aims to bring together researchers from various disciplines that are interested in all aspects of this area.

Ambient Intelligence is a recent paradigm emerging from Artificial Intelligence, where computers are used as proactive tools assisting people with their day-to-day activities, making everyone's life more comfortable.

After a careful review, 27 papers from 10 different countries were selected to be presented in ISAmI 2014 at the conference and published in the proceedings. Each paper has been reviewed by, at least, three different reviewers, from an international committee composed of 78 members from 24 countries.

Acknowledgments

Special thanks to the editors of the workshops: NTiAI .New Trends in Ambient Intelligence, CAIMaH. Challenges of Ambient Intelligence in the Workplace for the Management of Human Resources, AIfES .Special Session on Ambient Intelligence for Elderly Support.

We want to thank all the sponsors of ISAmI'14: IEEE Sección España, CNRS, AFIA, AEPIA, APPIA, AI*IA, and Junta de Castilla y León.

ISAmI would not have been possible without an active Program Committee. We would like to thanks all the members for their time and useful comments and recommendations.

We would like also to thank all the contributing authors and the Local Organizing Committee for their hard and highly valuable work.

Your work was essential to the success of ISAmI 2014.

June 2014 The Editors

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Contents

Context-Aware Automatic Service Selection Mechanism for Ambient Intelligent Environments

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Abstract. To develop context-aware Ambient Intelligence systems, suitable context models and reasoning approaches are necessary to provide the suitable services to users in dynamic and transparent manner. Due the advantages in modeling dynamic systems, Colored Petri Nets are adopted in this paper. So based on Colored Petri Nets modeling language, we propose a context-aware automatic service selection mechanism for intelligent environments. Using this formalism we also propose a solution to avoid conflict that can occur among resources sharing.

Keywords: Ambient Intelligence, Context Awareness, Multi Agent Systems, Colored Petri Nets, conflict resolution.

1 Introduction

The concept of Ambient Intelligence (AmI) has been introduced by European Commission's Information Society Technologies Advisory Group (ISTAG) [10]. AmI describes the future vision of computer science [23]. It deals with the vision that computing and communication ability are spread everywhere among nearly every object in our daily environment. An ambient system is a ubiquitous environment capable to interact intelligently with users and to provide the users with all the available functionalities and services in a *flexible*, *integrated* and almost *transparent* way for the end-user. For this purpose objects forming ambient systems must have some characteristics such as *autonomy*, *reactivity*, social abilities and *proactivity*.

The agent-based paradigm is one of the paradigms that can be used for the implementation of distributed systems. Typically, an agent has four properties [11]: *autonomy*, *social* ability, *reactivity* and *pro-activeness*. A multi-agent system (MAS) is a federation of agents interacting in a shared environment that cooperate and coordinate their actions given their own goals and plans. A MAS design can be beneficial in many domains, particularly when a system is composed of multiple entities that are distributed functionally or spatially [7]. Based on the above definitions, it is clear that agent paradigm is particularly appropriate for AmI. For these reasons, the use of MAS technology in ambient environments has been addressed in many researches like [2, 3], [5], [9], [21].

C. Ramos et al. (eds.), *Ambient Intelligence - Software and Applications*,
Advances in Intelligent Systems and Computing 291,
DOI: 10.1007/978-3-319-07596-9_1, © Springer International Publishing Switzerland 2014

To provide intelligent and pertinent services to users, AmI-based systems are expected to use contextual information such as location, identity, time, presence, temperature, etc. Dey and al [6] define the context as any information used to characterize the situation of an entity, which can be a person, a place or an object. A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task [8].

In this paper we focus both on context awareness and planning ability on ambient environments and we present a context-aware automatic service selection mechanism. Our proposed mechanism based on Colored Petri Nets (CPN) modeling language (an extension of Petri Nets (PN)). CPN are used to model contextual information and reasoning about. Based on this formalism we have proposed a solution to avoid conflict that can occur among resources sharing. The remaining part of this paper is organized as follows: section 2 shows a brief overview of the PN based context-awareness and MAS planning for AmI. The key concept of PN and CPNis given In section 3. In section 4, we present a context awareness modeling principals and we explain the reasoning process for context aware automatic services selection. An illustrative scenario is given in section 5. Finally, we recapitulate the main arguments and present some outline of future work.

2 Related Work

In this section, we briefly present some related work on multi-agent planning and Petri net-based context modeling for AmI systems.

Weld defines the planning problem as follows [24]. Given a description of the known part of the initial state of the world, a description of the goal (i.e., a set of goal stats), and a description of the possible actions that can be performed, modeled as state transformation functions. In the domain of AmI, to develop a planning mechanism we might take into consideration that distributed devices composing such systems are more compact in size, but their CPU and memory are much less powerful, and are often battery-powered. Consequently, these devices could not perform complex computations such those required by planning tasks. Because of AmI systems features, centralized planning is suitable. Many researches have proposed the use of man centralized components such [3, 4]. In [3] for example, the authors study what is the planner most appropriate for AmI systems. They have proposed the D-HTN (Distributed Hierarchical Task Network) planner. They based on the idea that, each smart spaces is equipped by an agent called majordomo that deals with the planning and execution activities and it is composed of one agent called device agent (split in the cooperative semiagent (CO) and the operative semiagent (OP)) for each device present in the environment. Really, for the required flexibility of the system and the number of devices involved, it is obvious that centralized control is not viable. However for limited smart spaces like smart homes, conferences rooms and many others, centralized planning could be adopted as solution. For systems with a large number of individuals we might push toward distributed planning. Authors in [19] present

Context-Aware Multi-Agent Planning (CAMAP), an approach for multi-agent planning that applies argumentation mechanisms to decide the most appropriate course of action according to the context information distributed among the agents. CAMAP is applied to AmI environment in the field of health-care.

Recently, the PN-based context-awareness modeling approaches were proposed in several works and they have been recognized as promising context models [20]. This is due mainly to both formal and graphical nature, expressiveness, and analytical property of PN. Modeling with PN inherently satisfies the requirements of context model, especially the usability of modeling formalisms and representation of relationships among context information [20]. Kwon [14] proposed an extension of CPN called Amended CPN to represent and analyze the context-aware systems. In this work the system is decomposed into several meaningful subsystems as a pattern. Amended CPN consist of multiple CPN, the Pattern and Context net represent contextual state and dynamic contextual change of another dimensional PN. As we proposed also in this work, in [14] each context type (location, weather, etc) is identified as color in Amended CPN and contextual information can be represented by a set of colors. Wang and Zeng [22] proposed a modeling methodology allows nondeterministic time duration for the activity. It permits to estimate the minimum and maximum duration time of each activity when the model is built. Moreover, it includes the resource constraints representing the resources which must be satisfied for executing the services. There are two kinds of places in the PN model for representing the activity and resources, Pa and Pr, respectively. A Pr containing a token means that the corresponding resource is available. Time and resource are critical ingredients in context-aware environment. This approach is one of the rare ones that consider both the time and resource constraints. However it presents few detailed information to represent resources constraints.

The related work presented above is summarized in Table 1. This paper contributes with the design of a model for Context-Aware Multi-Agent Planning, applied to Smart Home scenarios in AmI environments. Our approach uses CPN to model context and different services. We present also a solution to resource conflict occurring when services compete for the same resource in the same period of time.

Table 1. Summary of the related work

	AmI	*PN*	*MAS*	*Resources constraints*
[3]	Yes	No	Yes	No
[4]	Yes	No	Yes	No
[20]	Yes	No	Yes	No
[15]	Yes	Yes	Yes	No
[23]	Yes	Yes	No	Yes
Our approach	Yes	Yes	Yes	Yes

3 Concept of the Petri Nets

In contrast to (ordinary) PN, in which a token are uniform and represent typeless information, CPNs can carry complex information. They provide data typing (color sets) and sets of values of a specified type for each place. Formally a CPN [12] is a structure (P, T, A, N, ∑, V, C, E, G, M0), where:

- P, T, A are finite set of places, finite set of transitions and finite set of arcs, respectively. Such as $P \sqcap T = P \sqcap A = T \sqcap A = \emptyset$;
- N : is a node function such as : A→ (P x T ∪ T x P);
- ∑ : is a finite and non-empty set of data types, also called color sets or colors.
- V: is finite set of typed variables such as: TYPE [V] ∈ ∑;
- C: is a color set function. It assigns a color type (set) to each place: P→ ∑;
- E: A→ Expression E(a) of type C(p(a)), is the arc function. It maps each arc to an arc expression such: $\forall a \in A : [\mathrm{Type}\left(E(a)\right) = C\left(p(a)\right)_{MS} \wedge \mathrm{Type}(\mathrm{Var}(E(a))) \subseteq \Sigma]$ Where p(a) is the place of N(a);
- G: is a guard function. It assigns a guard to each transition. It is defined from T into Boolean expressions such that : $\forall t \in T : [\mathrm{Type}\left(G(t)\right) = \mathrm{boolean} \wedge \mathrm{Type}\left(\mathrm{Var}\left(G(t)\right)\right) \subseteq \Sigma]$
- M0: is the initial marking. It is defined from P into expressions such that: $\forall p \in P : \left[\mathrm{Type}\left(I(p)\right) = C(p)_{MS}\right]$

A transition t is said to be enabled if and only if the guard function G(t) attached to this transition is evaluated to true , and all of its input places are marked with at least E(p, t) tokens. The firing of an enabled transition t removes E(p, t) tokens from each input place p of t and adds E(t,p) tokens to each output place p of t.

4 Context-Aware Automatic Service Selection Mechanism

The multi agent architecture used for developing context awareness applications for smart spaces can contain mainly three types of agents: Planner Agent, Context Manager Agent and Sensor Agents (Fig 1). Agents communicate by sending and receiving messages following the hierarchy using communication language such as ACL (Agent Communication Language) language. *Sensor agents* residing in sensor level represent all perceptual components. Perceptual components are distributed through the environment, in order to provide a detailed model of the real world and make it available to the application. They provide elementary contextual perceptual information which is a key component of context awareness systems. In *Context Management Level***,** an agent gathers data from different sensor agents. It aggregates sensor data over a time period. It can also deduce high-level context information from basic sensed contexts. The reasoning process is carried out by the Planner Agent in *Reasoning & decision level***.** The reasoning about context is the process of mapping between context and services. Planner Agent uses information provided by Context manager Agent to select a set of possible services from Services library.

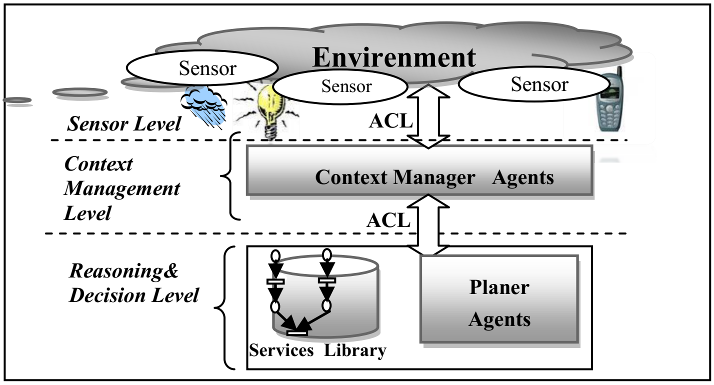

Fig. 1. Multi-Agent Architecture in Smart Home

4.1 Modeling Principles

The real world presents a dense multi-dimensional contextual space. Representing all of them is impossible for many reasons: i) this needs an enormous memory space; ii) some information is irrelevant or less important than others; ii) in practice, some type of context can't be captured, or it is expensive to capture them. So to develop context awareness applications, the first step consist of selecting form infinite contextual information list, those which are the interesting ones. In this setup, designers must determine which types of contextual information to be captured and to be used by the application.

After determining which information should be perceived and collected. The question now is how to represent context and how to reason about. Context modelling and reasoning are the core components of context-aware systems. In the following sub sections, we discuss of key concepts that can be modeled by CPN constructs (Fig. 2).

Context Modeling. Context-aware computing is the ability of applications to discover and react to changes in the environment in which they are situated (17). In order to represent the context and to reasoning about, we propose the adoption of CPN based model. With the flexibility of token definition it is possible to use them to model various contextual information. A context is a set of contextual information such as Context = C1* C2*…*Cn.

Resources Modeling. In the modeling of plans using CPN, we represent resources by resource places. We can use one resource place for each resource type as we can use one single resource place with a composite data type for convenience. In Fig. 1, PR1, PR2,…, PRn are resources places. An arc from action transition to resource place means that the execution of the action needs one (or more) resource (s) of that type.

Services Modeling. A service is a set of predefined ordering actions that refer to one (or more) contextual situation (s) (e.g. real world situation(s)). To model a service by CPN we use transitions to represent actions whereas places are used to represent actions stats. All service models will be stored in a plan library witch be used later by planner agent.

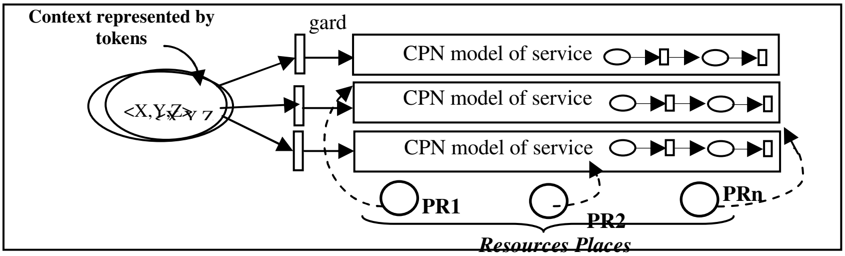

Fig. 2. CPN-based Context Awareness Modeling.

4.2 Reasoning about Context

Reasoning is used to decide what services should be invoked when any change of context occurs. Fig.3 shows the proposed service selection process:

Context Delivering & Management. In order to provide proactive and adequate services to the user, context delivering components have to be integrated. The role of these components is to continuously track information about user and his environment. Context management includes many operations such as sensor data aggregation over a time period and inferring high-level context information from basic sensed contexts …etc.

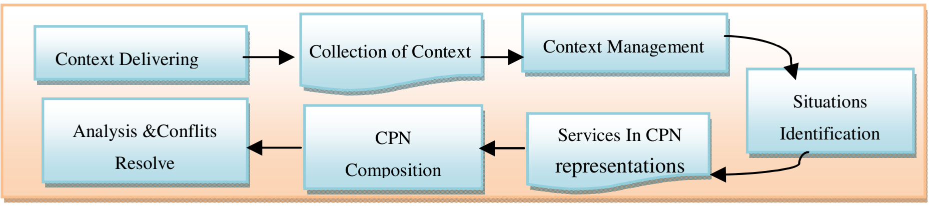

Fig. 3. Services Selection Process

Situations Identification. The reasoning about context is the process of mapping between context and services. A situation can be defined by collecting relevant contexts, uncovering meaningful correlations between them, and labeling them with a descriptive name. The descriptive name can be called a descriptive definition of a situation, which is about how a human being defines a state of affairs in reality [13]. Situation Identification is the processes to deriving a situation by interpreting or merging several pieces of perceived information. Situation identification techniques have been studied extensively in AmI. The most promise one have been highlighted in [13]. In this stage all possible contextual situations will be identified. Each contextual situation represents a service modeled by CPN. Services models are created by designers of context-aware applications. According to token values, all possible services models will be selected from service models library. The Planner Agent will have *n* CPN service models (*n* is positive integer).

CPN Composition & Conflict Resolution. It is possible that for some context values many services can be invocated. However in certain cases conflict among resources sharing can bloc system evolution. In the other hand, in many cases some types/values of information are more important than others, or in other words not all services have the same importance. As an example, consider the tow following information: "the gas range is turned on for 10units of times" and "weather is raining". In this situation, conflict among resources which are windows could happen. Because it is raining windows must be closed. In the other hand the windows must be opened because the gas range has been turned on (if there are not other kinds of aeration). From our point of view, this phenomenon can be avoided by *Establishing Priority for Services*. To do that, we propose in this framework to classify services into several types. For each service class we associate a priority level as fallow: *class 1 → level 0 (higher priority), class 2 → level 1 ,…, and class n → level n-1 (lowest priority)*

The priority mechanism can be applied using CPNby assigning priority to transitions. We choose to define priority as a positive real-valued function over transitions, the higher the value, the greater the priority. So we define the priority function ρ mapping a transition into R^+. When two transitions are enabled, the one with the highest priority fires. All transitions forming the same service model have the same priority. The role of priority transitions appears in merging services models phase where conflicts among resources can take place. After applying priorities and merging CPN Models the resultant net will be executed to obtain the order in which a set of possible services are executed.

5 Illustrative Scenario: Smart Home

AmI can be applied in any dynamic environment where is a need to manage tasks and automate services (e.g., hospitals schools, homes, etc). Abascal et al [1] assumes that home is the ideal place to apply percepts and technologies for giving high- level services to the user. Smart homes represent the ideal solution for individuals with different needs and abilities (child, old, blind, handicap, etc). So we illustrate our approach through smart home scenario. The main expected benefits of this technology can be: i) *Increasing safety*: e.g., by automating specific tasks that an individual with disabilities or elderly can't perform them. Or by providing a safe and secure environment;ii)*Comfort*: e.g., by adjusting light, temperature , TV channels automatically);
iii)Economy: e.g., by monitoring the use of energy. To ensure these benefits, the system must provide many services. Services can be classified into three classes according to their objective. The first class represents services providing safety or security. The second class represents all services that provide users comfort, and the last one represents services having economic aspect. From our point of view, assuring safety of peoples has much important than assuring there comfort. For this reason, the first service class must have the higher priority. Concerning the second and the third ones, we assume that comfort aims became before economy one. For instance, if the user prefers high lighting, and energy module detects an over use of energy, the systems

will give more importance to user's preferences. The house is equipped with smart devices and sensors forming an AmI system. Imagine now that the owner of the house is sleeping. The weather is very could in outside (-5°), all windows all closed, and carbon monoxide (CO) alarms detects poisonous CO gas in home. The system uses this perceived information to select a set of possible services from Services library. In this case, tow services can be invoked. Fig. 4, Fig. 5 represent CPN model of selected services (designed with CPN tools [25]).

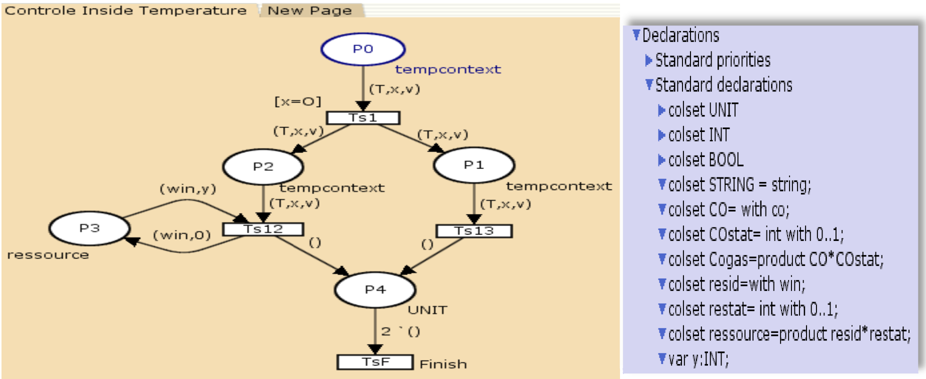

Fig. 4. Control Inside Temperature

The first service aims to regulate inside temperature. It is composed of the tow flowing actions: i) Close windows, ii) regulate inside temperature by increasing/or decreasing it. The second one aims to protect inhabitant life by performing flowing actions: i) windows must be opened; ii) occupant must be informed as soon as possible.

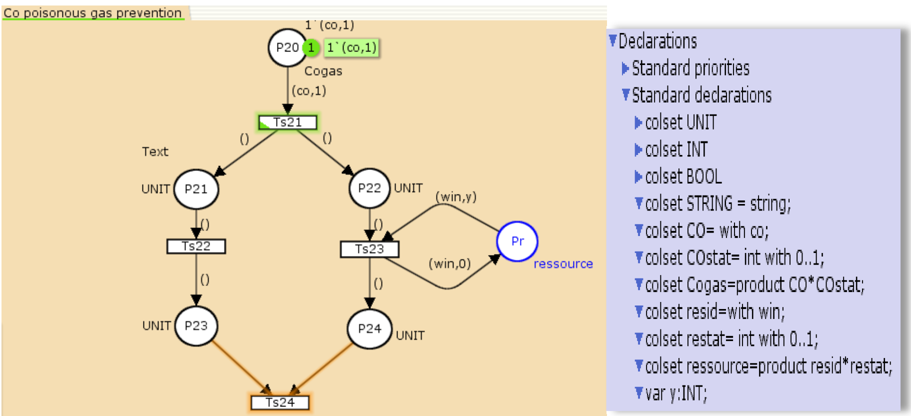

Fig. 5. CO Poisonous Gas Prevention

The CPN model presented in Fig. 6 is obtained by merging service 1 and service2 CPN models. Note that both services compete for the same resource (*Pr* place) simultaneously. Both of them pretend to take the control over windows. Our solution to this conflict pass through using priorities associating to services to choose which one has the privilege of accessing first the resource. Because service 2 deals with unsafe situation it will have the higher priority. So all transitions of service 2 model (Ts21, Ts22, Ts23) will have the higher priority, ρ (T)=1, and for all transitions *t'* of service 2 CPN model, ρ (T)=0. As consequence service 2 will be executed before service 1.

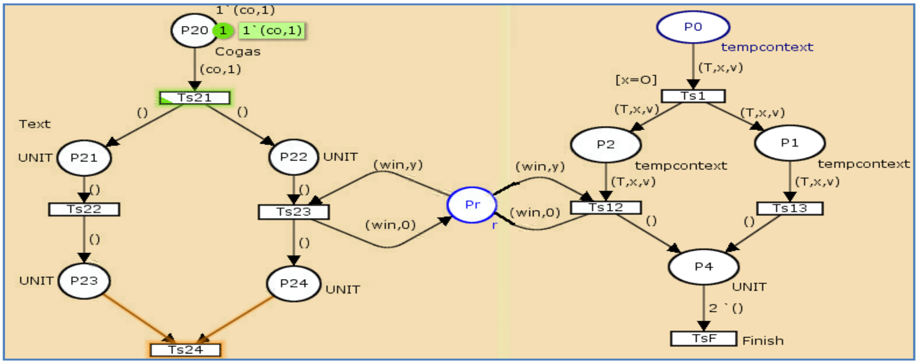

Fig. 6. The resultant Merged CPN

6 Conclusion and Future Work

In this paper we have proposed context-aware automatic service selection approach in intelligent environment. PN have been successfully used for modeling and analysis behavior of various complex dynamic systems. For this reason we have adopted CPN as modeling language to model contextual information and reasoning about. We have proposed a solution to avoid conflict that can occur among resources sharing. Our solution based on the idea of establishing priorities to services. Using CPN formalism, this idea has been represented by associating priorities to transitions. Future research would investigate the establishment of priorities in a flexible manner rather than being done during the development process. In this work only the conflict occurring among resources sharing has been taken into account. However, Conflicts can occur for many others reasons in AmI systems [25]. For instance, when there are conflicting user preferences in the same moment, e.g. One user prefers a lamp to be turned on while another user prefers that it should be turned off. So our efforts now are concentrated on expending the proposed reasoning process based on a formal model to detect other kinds of conflicts on AmI environments and resolve them.

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A Multimodal Conversational Agent for Personalized Language Learning

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Abstract. Conversational agents have became a strong alternative to enhance educational systems with intelligent communicative capabilities. In this paper, we describe a multimodal conversational agent that facilitates an independent and user-adapted second language learning. The different modules of the system cooperate to interact with students using spoken natural language and visual modalities, and adapt their functionalities taking into account their evolution and specific preferences. The results of a preliminary evaluation show that users' satisfaction with the system was high, as well as the perceived didactic potential and adaptive functionalities.

Keywords: Multimodal conversational agents, e-learning, educative technology, natural language processing.

1 Introduction

Ambient Intelligence is characterized by intelligent, pervasive, and seamless computer systems embedded into everyday devices, tailored to the individual's context-aware needs and providing a natural and intelligent interaction. This way, multimodal conversational agents [1] have became a strong alternative to enhance multi-agent systems with these intelligent communicative capabilities [2].

With the growing maturity of conversational technologies, the possibilities for integrating conversation and discourse in e-learning are receiving greater attention. Using natural language in educational software allows students to spend their cognitive resources on the learning task, and also develop more social-based agents [3].

Current possibilities to employ conversational agents for educative purposes include tutoring applications [4], question-answering [5], conversation practice for language learners [6], pedagogical agents and learning companions [7], and dialogs to promote reflection and metacognitive skills [8]. These agents may also be used as role-playing actors in immersive learning environments [9].

C. Ramos et al. (eds.), *Ambient Intelligence - Software and Applications*,
Advances in Intelligent Systems and Computing 291,
DOI: 10.1007/978-3-319-07596-9_2,