Petri Net Modeling Dynamic Context of ambient Systems

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Abstract – An ambient System is a network of tools and equipment that interacts to fulfill someone needs. This equipment should respect the context in which they act. In order to correctly fulfill their functions, we need to specify these contexts. In this paper, we propose a new approach that allows 1) to model the ambient systems as a multi agent systems, and 2) to model both local context of each component and the global context of the ambient systems. The context is modeled using petri nets to formally verify and validate the system operations.

Keywords Ambient Systems, Multi Agent Systems, Local context, Global Context, Petri net

1. INTRODUCTION

The progress of the current computer leads ubiquitous computing where each object in the environment plays the role of a sensor unit, calculator or communication. However, the number and variety of smart devices raise concerns about the amount of time and attention that users must spend to interact.

This research is a part of the emerging field of ubiquitous computing with, as a subject of study, the notion of context. The objective is to arrive at a definition of the notion of context that is operational for purposes of man-machine interaction.

In this paper we are trying to overcome these deficiencies. In section 2, we introduce ambient systems and their context. Section 3 presents the different approaches of modeling ambient systems and context. In section 4, we describe our approach to model the ambient systems and context. This approach is based on multi agent systems and petri Nets. The section 5, we try to describe our approach thru an example.

2. AMBIENT SYSTEM AND CONTEXT

2.1. Ambient system

An ambient system is an invisible system present everywhere and anytime [2]. We are talking about the system that interacts with the environment changes and behaves according to these changes.

2.2. Context

Context is the adaptation of application to changes in its environment. The context is a set of information that is structured, shared, evolving and used to interpretation. [3]

Context is “Any information that can be used to characterize the situation of an entity (person, object or physical computer). More generally any element that may influence the behavior of an application”. [4]

BREZILLON [5] define the context by: “The context is what is not directly involved in solving a problem, but forced his resolution”.

2.3. Changes in the context

A context is defined by its situations and pred icates,Context = C (predicates / situations), oth erwise the context is defined by possible situations of the system and the functions that lead to these situations. [1]

C1.1, C1.2 are sub context of C1.
E: event that causes the change of context.
The context of the system changes if one or more context changes.
C=(c1, c2, c3, …ci) / C: system context, ci: sub system's context.

3. RELATED WORK

CONTINUUM project [1] proposed a model of context the context in terms of static time, using the functional and behavioral decomposition, which makes the role of programmer easier, but the work of designers increasingly difficult.
Several researches targeted the modeling of the context problem [10], [11], [12].

Petri Nets (PN): Several graphical modeling approaches to context-aware services have been proposed to implement an effective model that specifies the acquisition and management of the various components of the environment such as Unified Modeling Language UML [13], ORM Object Role Modeling [14] and Petri Nets. In this section, we will focus on Petri Nets.

Recently, many approaches to modelling context-aware systems based on PN have been proposed and have been recognized as promising and effective models for the representation of context [15] [16].

Colored PN (CPN): *Han et al.,* proposed a model that focuses on the transition contexts [17] [18]. It is able to check whether the system can provide service in a specific time when the context changes.

Silva et al., [19] proposed to combine 3D modeling tools with CPN for modeling 3D environments. In this model, the place is used to indicate the current state of the user and components such as PDAs and screen.

4. PROPOSAL APPRAOCH TO MODEL A CONTEXT

Our approach to model the ambient systems is based on the Multi-Agent System. Each component of the system could be considered as an agent

The global context will be constructed and managed by a common resource agent.

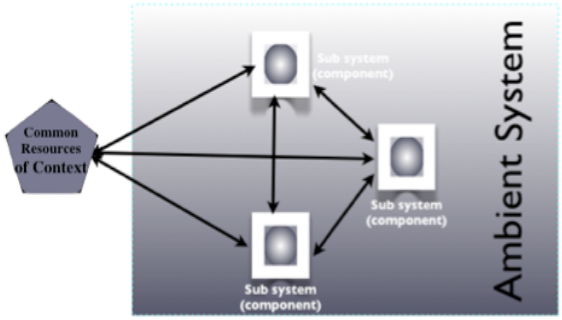

Figure1: Multi agent system for ambient systems

4.1. Our approach to model the context

Our approach is based on the decomposition of a system to subsystems. The designer defines a context C (p) by defining all entities (p) and predicates associated with this context:

C(p) = (Entities(p), Predicates(p)).

This formal model (predicate, entities) not allows us to see the relationship between the components and the events and not to have an overall view of the system context. To overcome this problem, we modeled each local context as a petri net.

4.1.1. Predicate

Propositional logic can essentially discuss grammatical connectors as of negation (¬), conjunction (◦) and disjunction (∨), composing proposals from proposals data.

4.1.2. Petri net

The Petri net (PN) is a graphical modeling tool for discrete dynamical systems. [20]

4.1.3. Nested net

The sets N_0,M_0 of nets and marked nets of depth zero are defined as the sets of colored nets and marked colored nets over the universe U_0, respectively. For each n > 0 the value universe U_n and the sets N_n , M_n of nets and marked nets of depth n are recursively defined by $U_n = U_{n-1} \cup M_{n-1}$ and N_n and M_n as the set of colored nets and marked colored nets

over U_n. We set $N_\omega = SS_{n\geq 0}N_n, M_\omega = {}_{n\geq 0}M_n$ and $U_\omega = U_0 \cup M_\omega$.

4.2. Modeling local context (sub system)

After generating the overall situation of our sub system, the common resources will turn in a formal model by applying transformation rules.

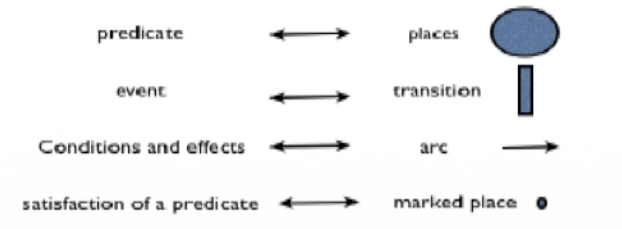

Figure2: Transforming rules

As a result we obtain a formal model based petri net of internal context of each sub system.
We illustrate with an example of a monitoring system with two sub-systems camera and door
The sub-system Camera has two predicates:

- Activatedcamera(): true if door is opened.
- Deactivatedcamera(): true if door is closed.

4.3. Modeling global context

After generating all the internal contexts of each sub system, the common resources will generate the overall context of the system by considering the addiction and relationships between sub systems.

5. APPLICATION

5.1. Description

Our application is a sub-system of the ambient system I-Home, this sub-system is called I-ALARM. [1]

5.1.1 Entities

- Person: individual.
- DAlarmSnore: device may emit an audible alarm.
- DAlarmLight: device capable of emitting light alarm.

5.1.2 Predicates

(1) isHourAlarm (Person p) checked if it is time for person to wake up.
(2) IsAwake (Person p): checked if person is awake.
(3)AlarmSonoreOn(DispositifAlarmeSonore []
d) checked if DAlarmSnore is active.
(4)AlarmLightOn(DispositifAlarmeLumineuse []
d) checked if DAlarmLight is active.

5.1.3 Situation

The common resource agent will collect elements of internal contexts (predicates and states) to generate the global possible states of our system.

5.2. Modeling the local context (petri net)

The common resource agent applies transforming rules to get the model of local context of I-Alarm.

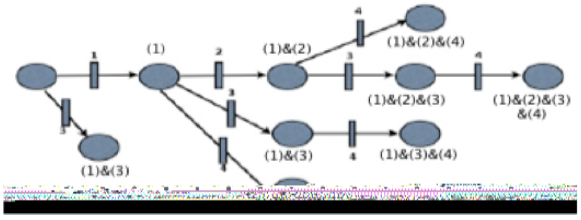

Figure3: Model of context of sub system I-Alarm

5.3. Modeling of overall context of the system I-Home (nested net)

After generating the models of local context of each sub system of I-Home, the common resource agent will build the global model of context taking into account dependences and relations between sub systems.
The result is a nested net of global context of I-Home given in the figure below

Figure4: Model of context of the system I-Home

6. CONCLUSION AND PERSPECTIVES

The purpose of this paper is to present a formal approach to model both the ambient system and its dynamic context.
To model the context, we used the Petri Nets method to better fit the dynamic environment of our system and clearly describe the event causing change in context. The model we have

proposed has checked some property such as reachability and security.

The perspectives of this study are:

I. Refining and detailing the MAS. To get a coherent system with regards to its context model, we are planning to use the Agent Architecture Description Language (AADL) to formally specify the MAS for the ambient system.

II. Checking other properties such as integrity and compatibility with other environments.

III. Implement a complete application.

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