OXSY 2005 Team Description

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Abstract. This paper describes current architecture of our team Oxsy, architecture based on one used in the past two years in Padua and Lisbon in (RoboCup) competitions. This architecture named (PROSA) is composite from several (Holons) and we used it like approach for the simulation soccer. The concept of "Holon" coming from the industry (intelligent manufacturing systems) has been proved to be very successful in increasing the flexibility of decisional systems. While MAS (multi agent system) are already largely applied in such systems, in this context, simulated soccer (RoboCup environment) became a test bench for further challenges. This architecture tries to combine in synergistically manner the characteristics of both domains: MAS and HMS.

1. Introduction

This year we extended our architecture with a new level, that is "Coach Level". Before to present this new level we take a briefly review about what is the meaning of "Holon" and also it's advantages for use in that kind of environment.

Multi-agent (intelligent) systems (MAS) are software systems composed of several autonomous software agents running in a distributed environment. Besides the individual goal of each agent, global objectives are established committing all or some agent groups to their completion. This type of system is widely used in implementing teams for robotic soccer (RoboCup).

This concept of "Holon" was proposed by the Hungarian philosopher A Koestler (1967,1978) and explains the importance of the hierarchy of a system. Each organ is an element of the organic system while the organ is itself a system composed of multiple tissues. This relationship appears at every level of the system. This means that a system element is located at a hierarchy node and has both characteristics as a whole and as a part. Koestler named the node of hierarchy "holon". (Hino R. 1999) based on the combination of the Greek word "holos" that means "whole", and the suffix "on" meaning particle or part. Accordingly a "holarchy" is a hierarchy of self- regulating control building blocks (Holon), which function:

(a) As autonomous wholes in supra-ordination to their parts;
(b) As dependent parts in subordination to controls on higher levels;
(c) In coordination with their local environment;

2. Why are we using holarchies?

By definition, the “Holon” is an excellent concept for modeling a soccer team because of its main characteristic: it can act as a part (modeling a player) or as a whole (modeling the team).

One of the most important characteristics of the holarchies is the capacity to modify themselves, i.e. to create temporary hierarchies (Giebels, M. et. al. 1999). Like modern industry, the soccer is very dynamic, i.e. not only that each team comes with its own style and game strategy, but also each game phase has a dose of novelty. In this way, it isn’t possible to create only one command scheme that will work correctly for each adverse team and each game phase. The holarchies aren’t rigid, they change themselves according to necessities (strategic and tactic) and the structure of the decisional schema will dynamically change (by modifying momentary priorities).

Another advantage of the use of holons is providing a balance between the two possible approaches of the leading process: the hierarchical control (fixed, static, pre-established) and the hierarchical (autonomous, decentralized, flexible but not very efficient). (see Fig. 1)

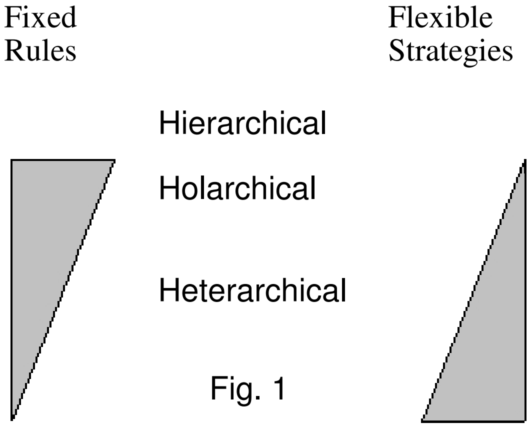


Fig. 1

A (Holon) is the fundamental part of any holarchy, and it can be referred to as an agent who has outspoken cooperatively and autonomy characteristics.

The (Holon) has two communication channels with the outside world, as it can be seen in (Fig. 2). One of this channels is used for communication with the others holons and the other one for acquiring information from the environment. The reactive layer – obviously indispensable – underscores one the main common features of holons and agents.

The most important part of the holon is the planning process set up in the deliberative layer. The planning process uses data acquired on the two communication channels – a) with the environment (receiving stimuli and sending response to them), and b) with the other holons (taking advice from the higher level, negotiation with adjacent holons monitoring subjacent holons)

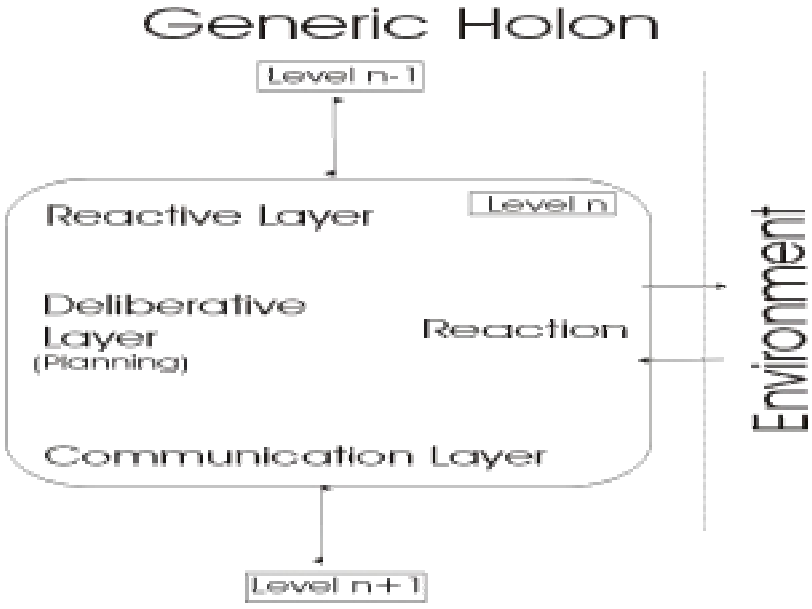


Fig. 2

The negotiation part (implemented in the communication layer) is activated in two situations. The first situation is when it receives some advice that can't be accepted (executed); in this situation it can inform the caller what can be done (i.e. it has other tasks more important for it or it can't implement the advice because of lack of capacities). The second situation is when it sends an advice to a other (Holon) and receives a rejection. Based on this refuse it can begin the negotiation process, which consists in redefining the advice (less requirements) or in task decomposition (it will try to assign more holons to solve the initial task).

3. Architecture

Our architecture is based on the PROSA model developed at PMA/KULeuven as a reference model for Holonic Manufacturing Systems (Van Brussel at al. 1998, Wyns 1999). The acronym PROSA came from Product-Resource-Order-Staff Architecture, the holons type used. The *resource holons* contains a physical part namely a production resource of the manufacturing system, and an information processing part that controls the resource. The *product holon* holds the process and product knowledge to assure the correct making of the product with sufficient quality. The *order holon* represents a task in the manufacturing system. It is responsible for performing the assigned work correctly and on time. The *staff holon* is implemented in the idea to assist the rest of three holons in performing their work.

Hr	Holon Resource
Ho	Holon Order
Hp	Holon Product
Hs	Holon Staff

Level 0	RoboCup Environment	**Ho** Competition Rules
Level 2	Team	**Hr** Game Scheme, Players **Hp** Strategy Based On Opponent Modeling **Ho** Strategy Advice For Winning The Game **Hs** Spares Players
Level 3	Player	**Hr** Resources **Hp** Skills **Ho** Individual And Team Strategy **Hs** Body Components
Level 4	Player Components	**Hr** Legs, Neck, Head **Hp** Kick, Dash, etc **Ho** Execute base command(Kick, Dash, etc.)

At the (level 0) we have the “RoboCup environment” containing the soccer server rules (Cortner et al. 1999, Noda et. al. 1998).

At the (level 2) we have holons who implements some game schemes, strategy based on opponent modeling and also support for asking spares players (heterogeneous). Communication with others holons from others players can be made through (Say) command.

At the (level 3) we have holons who implements the skill (i.e. pass, dribble, score), the goal oriented behavior and the strategy.

At the (level 4) we have holons who implements effectors (like body components) that can do actions (like kick, dash, etc.).

All these levels should be understood like a holarchy not as a hierarchcal organization.

As we said at the beginning of this paper, for this year we extended existing architecture with one more level. (Coach Level)

Level 1

Coach

Hr Spares Players, Global View And Noisily Free

Hp Change Players, Opponent Modeling

Ho Analyze Opponent Strategy

Hs Previous Opponent Log Games

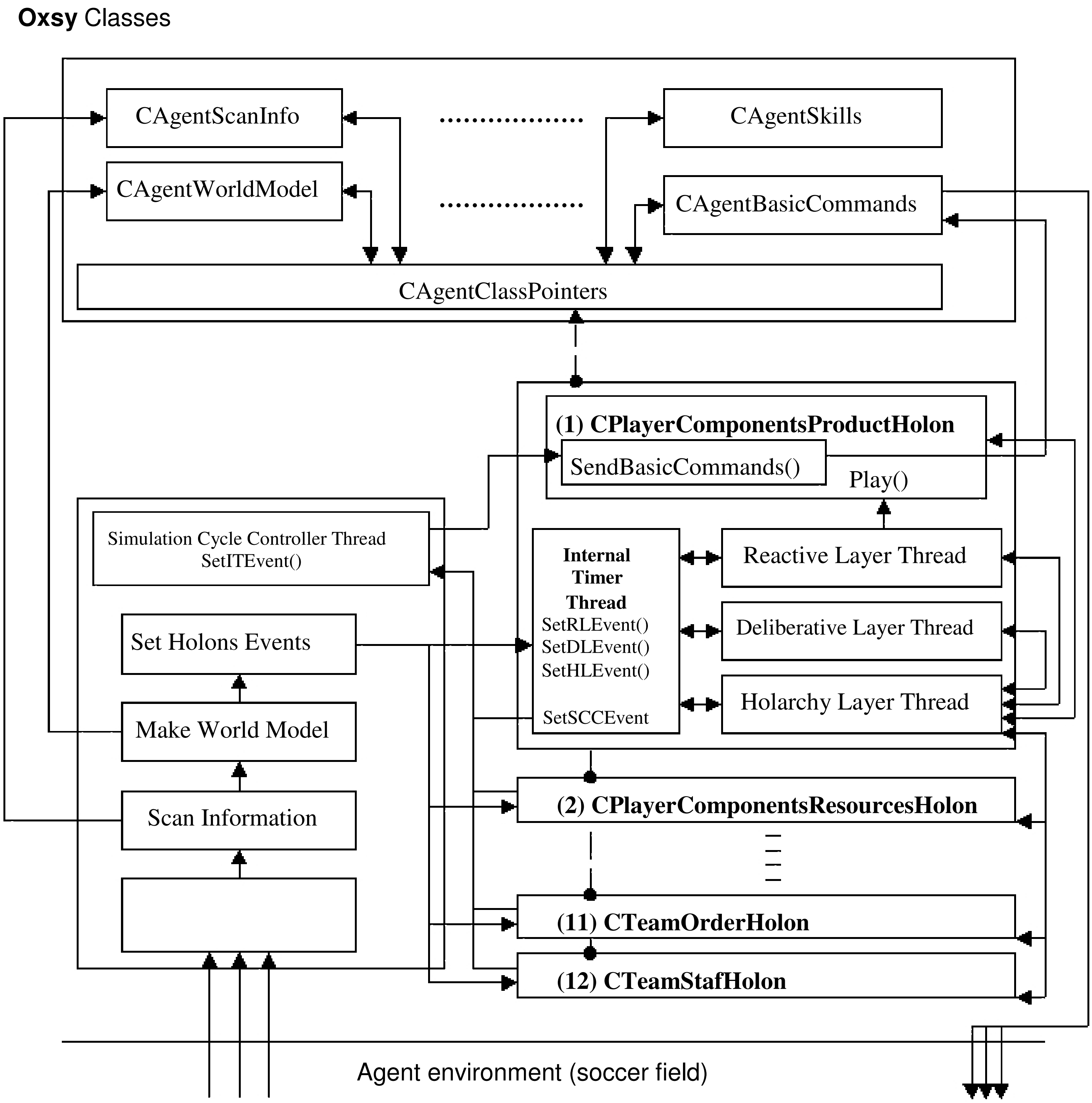
At this level we have holons who implements opponent strategy analyzing, opponent modeling without noisily, make some player changes (heterogeneous). Communication with others holons from others players can be made through (Say) command.

5. Implementation

As we mentioned earlier, our architecture is based on the PROSA model where each holon has a well-defined functionality. The holons that we are using have similar functionality with the original (Table 1).

PROSA	**Coach** Level	**Team** Level	**Player** Level	**Player Components** Level
Product Holon	- change players depend of the game state - opponent modeling in live games or analyzing different logs	- strategy depends of the game state - players positioning and regioning +others advice(pressing, support, etc)	- strategy(demarcate, solve some situations) - skills(ball intercepting, ball handling, pass towards team mates, shoot towards goal, dribbling, etc.)	- kick ball - dash forward or backward - turn neck or body - view width narrow, normal or wide - speak (say) - listen (hear)
Resource Holon	- spares players (heterogeneous) - global and noisily free view	- game schemes (learn and test schemes) - players	- learned skills - stamina - player components	- legs - neck - head - (eyes, ears, mouth)
Order Holon	- analyze opponent strategy	- advice for wining game(load strategy files automatically depends of the game state)	- wins: (ball, duel, positions) - keep safe: (ball, energy) - takes roles	- execute base commands (Turn, Kick, Dash, etc.)
Staff Holon	- watch some previous opponent log games	- spares players	- co-operation plan distributed through all players - strategically positioning for players in different game phases using neural networks	„unimplemented yet”

Table 1



Block schema of our implementation

6. Conclusions and future work

In this paper we describe our architecture that tries to combine in a synergistic manner the approaches applied in two, up to now insufficiently related domains: MAS and HMS. The preliminary results suggest that we are in a very promising starting point for future work (the new team won all the games played against the 2003 and 2004 team). This validates the approach of adding functionality (first of all, flexibility) stepwise, i.e. improving the 2003 architecture. With this new "**coach**" level, we increase the architecture flexibility substantially. The result show that at this stage the most useful is the resource holon. For the game strategy the order holon is still insufficiently adapted. The staff holon will be useful when the evolution of the game rules will give an even more substantial role to the coach. Another problem for the future is improving negotiation between holons.

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