Humans and Agents in 3D Electronic Institutions

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ABSTRACT

In this paper we propose the use of 3D Virtual Worlds for the visualization of Electronic Institutions. We show how 3D representation helps to *open* Electronic Institutions to human users and support co-learning between autonomous agents and humans.

Categories and Subject Descriptors

I.2 [**ARTIFICIAL INTELLIGENCE**]: Distributed Artificial Intelligence—*Multiagent systems*

General Terms

Human Factors

Keywords

Electronic Institutions, 3D Virtual Worlds

1. INTRODUCTION

Most research in the Multiagent Systems (MAS) field has concentrated on theories, languages and methodologies aiming at building completely *autonomous* agents. However, not much attention has been paid to the relationship that an autonomous agent and its principal have, although several MAS industrial applications [3] have pointed out that humans participating in complex decision making tasks quite reluctantly delegate these activities to a completely autonomous entity. In areas like E-Commerce even if an autonomous agent has received precise instructions, a human will still insist on having means to observe the behavior of the agent and to intervene in the decision making process. A better understanding and modeling of the relationship between humans and agents that make decisions on their behalf is needed.

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We propose the use of 3D Virtual Worlds to support this relationship so humans can establish trust in the behaviour of their agents and intervene in the decision process at any time. A kind of "flexible delegation mechanism" that ranges from non-delegation at all to complete delegation, passing a set of intermediary steps where humans and autonomous agents co-operate in the problem solving process. In this way we expect that the deployment of real applications can be sped up and based on more solid pragmatic grounds.

We build on top of the Electronic Institutions methodology [4], as we think it is clear and based on a strong metaphor of human institutions. Moreover, it is supported by a significant amount of design and development tools [1]. Electronic Institutions are normalized agent environments where institutional norms are enforced.

Our objective is to bridge the gap between the two metaphors, Electronic Institutions and Virtual Worlds, and combine them in the metaphor of 3D Electronic Institutions [2].

2. HUMAN FACTORS IN E-INSTITUTIONS

On the one hand, representing Electronic Institutions as 3D Virtual Worlds provides users with an immersive interface to observe the behavior of their autonomous agents and intervene in agents' decision process if necessary. On the other hand, Virtual Worlds offer an immersive environment which implicitly incorporates location awareness of other users and offers mechanisms for social interaction. They support to a certain extent the way humans operate and interact in the real world, going beyond the document and form based interface of the World Wide Web, putting the human "in" the World Wide Web rather than "on" the World Wide Web.

We imagine a 3D environment where the couple agent/principal is represented as avatar. Our view is that the agent and the human co-operate in the solution of the tasks the human has to deal with. We want to permit that either the human takes full control over an avatar or that the autonomous agent is in full charge of the decision making process. The autonomous agent is always active, and when a human is driving the avatar the autonomous agent is observing the behavior of the human, learning from his/her behavior patterns. Nevertheless, we want to allow other types of interaction among them, such as the human giving guidelines to the agent, or the agent suggesting potential solutions to the human, in a sort of "expanded intelligence" mechanism similar to the "expanded reality" that nowadays virtual reality tools offer.

Of course, not every Electronic Institution should be represented

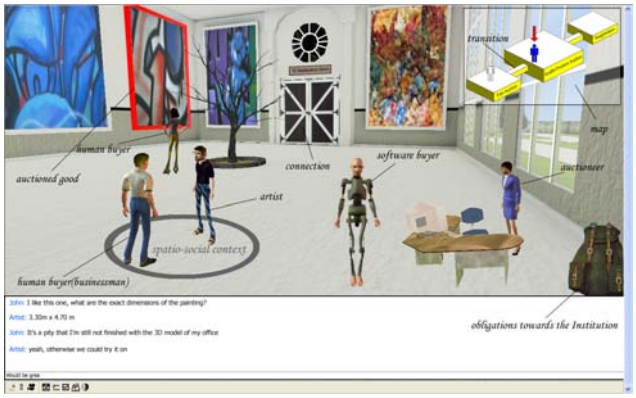

Figure 1: 3D Electronic Institution example

in 3D. In our opinion, the application domain which will highly benefit from the use of Virtual Worlds is E-Commerce. Virtual Worlds are spaces where people "meet". Social interaction is a key feature and Virtual Worlds provide support for communication and collaboration of their participants. The support of social interactions is insufficient in E-Commerce, despite the fact that in real life commerce social interactions play an extremely important role [6].

Figure 1 depicts an example of a representation of an E-Commerce Electronic Institution - graffiti poster auction - as a Virtual World. In this environment participants of the gallery are embodied as avatars. The auction room reproduces a cosy atmosphere of a real world gallery. The auctioneer auctions the paintings. The buyers can discuss the paintings with other buyers or with the artist. The artist is present in the gallery during the vernissage. He looks for potential customers to offer them new pictures which will satisfy customer's individual requirements.

3. CO-LEARNING ASPECTS

The duality agent/principal permits the introduction of co-learning aspects into the system. On the one hand, the autonomous agent can learn from the principal how to take decisions, and after some period of learning take autonomous decisions in the same way the human would have taken them. On the other hand, the autonomous agent can help the human to learn the structure of the Electronic Institution. It can assist the user in learning the institutional rules or can advise the human on certain decisions on the basis of the information the agent may have gathered from external sources or from the observation of other participants' behavior. In some institutions agents may also observe conversations of other agents and extract important information for their principals.

Adding new dimensions and new degrees of freedom to a user interface provides new opportunities for collecting information and learning. Interaction in 3D Virtual Worlds involves typical real-world actions such as moving, changing directions of movement, changing the point of view without changing the position (1st vs 3d person view), turning around and inspecting objects, etc. At each step on a trajectory in the world, there is a large number of possible actions to observe and learn from.

4. SYSTEM ARCHITECTURE

The proposed framework consists of 3 layers: Electronic Institution Layer, Communication Layer and Interface Layer.

The *Electronic Institution Layer* uses the functionality of AMELI provided with Electronic Institutions [1]. It is the infrastructure that mediates the agent's interactions while enforcing the institutional norms. Participating agents may be heterogeneous and self-interested, and therefore we cannot assume that they will behave in a benevolent way. AMELI is a domain independent component that supports the execution of such heterogeneous agents.

The *Communication Layer* performs the task of *causally* connecting the Electronic Institution Layer (AMELI) with the user interface. A system is said to be "causally connected" to its representation if whenever a change is made in the representation, the system itself changes to maintain a consistent state with the changed representation, and whenever the system evolves, its representation is modified to maintain a consistent relationship [5]. *Reflective systems* are a particular case in which the representation of the system is part of the system itself. An Electronic Institution has a representation of itself in terms of a 3D Virtual World consisting of rooms, avatars, doors and other graphical elements. This causal connection has to materialize in two directions. *First*, actions made by the agent in the institution have an immediate impact on the 3D representation. Movements between scenes, for instance, must make the avatar "move" in the 3D world accordingly. Messages said by the agent must be considered as said by the avatar. *Second*, actions performed by the avatar in the Virtual World are understood as made by the agent in AMELI. This has as a consequence that those actions that the agent is not allowed to do in the current execution state cannot be permitted over the 3D environment. For instance, if an agent cannot leave a scene, opening a door must be prohibited to the avatar. Those actions that are permitted in the current state and are actually performed by the human, must have the same impact on the Electronic Institution infrastructure supporting the execution as if they were made by an autonomous agent.

All events performed by a user in the Virtual World are passed to the Causal Connection Server. Such an event might be a request for the action of opening a door or typing the price the user is willing to pay for an auctioned good. Before executing an action the Causal Connection Server captures these events and sends them (in terms of messages) in turn to AMELI for "validation". More precisely, AMELI checks whether a particular message goes in line with the electronic institution rules or not. If a positive validation response is given by AMELI, the requested action gets the permit to be performed in the Virtual World.

The *Interface Layer* is simply responsible for the visualization of 3D Virtual Worlds and reflecting the approved actions onto them.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Electronic Institutions Web site. http://e-institutor.iiia.csic.es.

[2] A. Bogdanovych, H. Berger, C. Sierra, and S. Simoff. E-commerce Environments as 3D Electronic Institutions. In *Proceedings of the E-Commerce 2004 conference*, pages 237–242, Lisbon, 2004. IADIS Press.

[3] G. Cuní, M. Esteva, P. Garcia, E. Puertas, C. Sierra, and T. Solchaga. MASFIT: Multi-agent systems for fish trading. In *Proceedings of the 16th European Conference on Artificial Intelligence, ECAI04*, page In Press, 2004.

[4] M. Esteva. *Electronic Institutions: from Specification to development*. IIIA Ph. D. Monography Vol. 19, 2003.

[5] P. Maes and D. Nardi. *Meta-Level Architectures and Reflection*. Elsevier Science Inc., NY, USA, 1988.

[6] J. Preece and D. Maloney-Krichmar. *The Human-Computer Interaction Handbook*, chapter Online Communities: Sociability and Usability, pages 596–620. Lawrence Erlbaum Associates Inc., 2003.