Universitatea *Transilvania* din Braşov

HABILITATION THESIS

SUMMARY

VIRTUAL ENVIRONMENTS FOR EDUCATION, TRAINING AND CULTURAL HERITAGE

Domain: COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

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This paper presents an incursion personal to the author into the context of VE, starting from its structural elements, taking into account the usability mechanisms in assuring its evolution to be credible, and ending with the means of exploration and interaction which the beneficiary of such an environment could use.

In this direction, chapter 2 debuts by introducing the notion of informational space, utilised in the definition of the VE. The model which we presented is populated with virtual entities that correspond to the objects from the real world. In our approach, the "meaning" of a virtual entity is its associated real object.

In order to be able to model this object, the utilisation of its essential properties is needed. These properties will constitute the object's "meaning" from the modeler's point of view. In the case of the virtual space, for each property of the real object considered to be essential by the modeler, there will be an attribute of the virtual entity, together with its informational form.

The real object's property becomes the "meaning" of the informational form associated with the attribute. By inspiring ourselves from the visual perception and audio emission fields we introduce the concepts of nimbus and aura of the entities, as complex informational forms.

The entities can be specialised in being either receptors or effectors. A receptor is a detector of stimuli in an informational space while an effector achieves modifications in the forms of the entities, thus obtaining their actions towards the surrounding environment.

In order to model the virtual agents we will make use of aggregation entities. At the time the effectors and receptors are involved in such an aggregation, the resulting entity becomes a virtual agent. In any moment of the agent's life, its state is given by the attribute values, the generators of its informational forms. Variations of these attributes, which are perceived through receptors, as stimuli triggered by effectors.

Developing a virtual 3D environment addressed to a specific area must succeed the integration both of the subject matter and 3D multimedia resources corresponding to this model. In this regard, we have proposed an approach-oriented ontology, organized on three levels: the one portraying the model's domain, the one of the resource instances, and lastly the one responsible for the execution/simulation of the environment, which allowed us to respect the corresponding link between resources and their concepts, obtaining this way a clear "image" of the object's meaning and thus a semantical improvement of its virtual replica.

Once obtaining the structural image of the virtual environment, considering the evolutive nature of the virtual environment as being due to the evolution of its components, its agents in particular, in the third chapter, we took into consideration perception, motivation, and emotion as essential in obtaining a credible behavioral modelling of agents. The agent's decisional module consists of a collection of fuzzy cognitive maps. Concepts that constitute cognitive maps can be sensory (whether they express perceptual values), internal (if values contain knowledge or decisions) or motor (if the express evaluations of actions or objectives). At the current level of the module, the perception's transformations into possible behavioral answers of the agent and the selection of the agent's actions takes place.

In order to express the action plans we introduced three behavioral patterns, described in turn by using three types of altered cognitive maps.

Selecting the action takes place after the evaluation of action plans related to all active motor concepts. Map convergence corresponding to an action towards an attractor ensures the completeness or failure of the action.

Thus, considering the agent as the ultimate form of organizing the information within the virtual environment, virtual space is presented as a multi-agent system, which consists of a dynamic informational context, endowed with a population of autonomous heterogeneous interactive and evolutive agents.

An ontologies-oriented approach is reiterated in the case of defining actions of the virtual environment's dynamics. It gives us the opportunity to expand the agents' skills towards reasoning based on domain ontologies and obtaining a semantic evaluation of their actions in the environment, evenntually, even before they start to act.

Getting back to the virtual environment's user, in chapter 4 we considered it essential in offering him the possibility to explore the environment, action which is primarily aimed at obtaining knowledge on the structural and behavioral characteristics of the environment.

In this regard, we considered that the action begins by exploring the virtual environment through navigation, action with a great cognitive potential, because the user will build a mental representation of the environment's structure on the basis of time & space - distributed reference points, preferably interrelated.

What we consider to be important in terms of the user's navigation is both the metaphor of navigation and the device used in implementing the transposition of the user's intent of movement/orientation in the virtual environment by movements expressed in the real world.

We believe that the solution is even better if the user requires a relatively small quantity of explanations concerning what gestures are needed to achieve the actions in the virtual environment. This topic entails the solution subject presented as a panoramic navigation system in a 3D environment.

User immersion in a virtual environment can be radically improved once the user makes use of the interaction with environment elements, possibly by means of a haptic feedback technology. This technology has the advantage of involving the user in an active dialogue with the multimodal virtual environment by physical interactions.

To this end, we studied the user's evolution in exploring the environment and interacting with it, assisting through different methods, two visual ones and one utilizing the haptic feedback. The study results demonstrated that the visual assistance elements increased the sense of presence and knowledge within the user, allowing him/her a better perception of 3D space, proving to be a very effective method for navigation. On the other hand, the effectiveness of the haptic feedback method was confirmed especially during interaction times, because it allows the user to focus on the virtual object. Last but not least, we consider the use of this technology in handling virtual objects.

Chapter 5 performs a review of the outcomes of the major projects conducted by the author in the Laboratory of Research in Virtual and Augmented Reality, within the University Ovidius of Constanta. In this respect, the first projects implement educational virtual environments are addressing young people, children and students. The following virtual environments have proven their usefulness in training in medical fields. The chapter ends with a presentation of the challenges and results obtained during the implementation of a virtual environment promoting national cultural heritage.

The latter part structures the academic achievements and research conducted by the author, and succinctly presents future research intentions and professional accomplishments thereof.