Designing Multimodal Semantic Virtual Environments for Cultural Heritage

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In the field of Cultural Heritage (CH), multimedia interaction with VEs can be used for conservation and valorization. Multimodal interaction extends and adapts the access to informative contents to different types of users through haptic and acoustic interactions. VEs for CH pose some critical issues such as: consistency between VEs and related historical and cultural environments; realization of virtual characters that exhibit believable behaviors and interactions; effective multimodal rendering of the information associated to virtual objects (e.g. using haptic and acoustic displays).

This work presents a methodology for the design of VEs that aims at grasp directly the domain knowledge inside proper Ontologies. The goal is to make this design accessible even to domain experts not grounded in Virtual Reality. The Virtual Environment can be described using the conceptual space of the application domain: this make the design suited for domain experts and final users and increases the consistence and plausibility of the result. Furthermore an iterative process, based on user feedback, balance haptic and acoustic displays to improve their effectiveness on different type of users such as the visually impaired. An authoring graphic tool enables the changes of the multimodal display of virtual objects to account for user feedback. The general procedure is shown in figure 1: the domain expert describes the semantic of the scene using the domain language and concepts expressed in the Semantic Layer (SL). The SL is composed by: the Domain Knowledge (domain concepts), the Core Knowledge (a detailed formal definition of domain concepts) and the VE Knowledge (mapping domain descriptions to Scene Graph concepts). The software engineer can understand the description prepared by domain experts through the analysis of the definitions and of the relations expressed in the ontology. These concepts are then mapped to formal definitions and translated in concepts related to the Scene Graph data structures used to implement the VE. At this stage, a complete conceptual description of the Scene Graph needed to realize the initial scene is available. This description is enclosed in an OWL file and can be published and shared over the Semantic Web, or directly used to implement the scene with a chosen technology.

Starting from this description the software engineer can add hapto-acoustic (multimodal) displays to virtual objects using a graphical editor tool. When final users interact with the scene, their feedbacks are returned to the software engineer that can change accordingly the related hapto-acoustic effects through a graphical authoring tool.

Fig. 1. A schema that summarizes the proposed methodology. Domain experts specify domain concepts in their own language. On the other side users provide feedback about hapto-acoustic display of virtual objects to software engineer that can change accordingly the related hapto-acoustic effects through a graphical authoring tool.

The activity is in progress and by now it is possible to create the static part of the scene and to use the Editor to associate haptic and acoustic properties to its objects. Future work will concern the formalization of dynamic properties of the actors inside the scene, how the use of semantic allows to infer believable behaviours and interacton for a given actor, and how user can interact with the environment in a more flexible and effective way.