Procedural and semantic modeling of virtual environments for serious games development

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PROCEDURAL AND SEMANTIC MODELING OF VIRTUAL ENVIRONMENTS FOR SERIOUS GAMES DEVELOPMENT

MODELISATION PROCEDURALE ET SEMANTIQUE D'ENVIRONNEMENTS VIRTUELS POUR LE DEVELOPPEMENT DE JEUX SERIEUX.

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Abstract

Virtual environments are useful tools for visualization, discovery as well as training. In serious or learning games contexts, 3D graphical worlds, interaction, navigation and immersion capabilities are needed to propel narration and emotion. Furthermore, they are key elements to materialize pedagogical content and to support knowledge transfer. Semantic modeling, serious game classification and gameplay component identification allow generating serious game scenarios linked to the 3D world modeling and interaction or animation capabilities.

Résumé

Les environnements virtuels sont des outils utiles pour la visualisation, la découverte, aussi bien pour la formation. Dans les jeux sérieux ou les contextes d'apprentissage par les jeux, l'univers graphique 3D, l'interaction, des capacités de navigation et d'immersion sont ici également nécessaires pour effectuer la narration et l'émotion et en outre, ils sont des éléments clés pour concrétiser le contenu pédagogique et de soutenir le transfert de connaissances. La modélisation sémantique, la classification des jeux sérieux et l'identification des composants de jouabilité permettent de générer des scénarios de jeux sérieux liés à la modélisation 3D du monde et d'interaction ou des capacités d'animation.

Extended Abstract

Virtual worlds are useful tools for visualization, discovery, training or learning. Alas, modeling large and complex 3D database as well designing animation and interaction can be a tremendous task for serious game designers.

Generation techniques based on procedural modeling are a powerful and efficient tool for creating 3D-plausible urban or natural environments destined for visualization, simulation, training or game design. Using procedural modeling while building a virtual environment to support serious games can facilitate 3D graphics designers in their work. In a more advanced process, this can provide game designers an easier way to connect scenarios, animation and interaction to the 3D world components since the early design and modeling steps. According to complex 3D environment modeling, we focus here on urban environment generation. According to (Tutenel, Bidarra, Smelik & de Kraker, 2008), the promising directions of procedural modeling can be divided into three aspects: first, performance and interactivity of procedural modeling will continue to improve, often by means of parallel programming on the GPU. Second, road networks and urban areas will certainly continue to improve in variation and level of detail and third, the widespread deployment of procedural modeling by non-experts (e.g. game designers, artists, scenario designers) will offer them more intuitive controls and tools to generate complete landscapes and non-intrusive mechanisms to maintain the consistency among generated features.

One of the common approaches for procedurally generating cities is to start from a dense road network and identify the polygonal regions enclosed by streets. Then, subdivision of these regions results in lots, for which different subdivision methods exist. There are two ways to populate these lots with buildings: either the lot shape is used directly as a footprint of a building, or a building footprint is fitted on the lot. By simply extruding the footprint to a random height, it becomes possible to generate buildings (Greuter, Parker, Stewart & Leach, 2003). Urban environment generation methods can be based on hand-made maps created by 3D graphics designers but also using GIS data in order to respect, when needed, reality conformity requirements. Creating urban universe without any previous data, procedural modeling can be initiated from few parameters and a generation rules system, for instance when using L-systems (Prusinkiewicz & Lindenmayer, 1990). In our serious games development activity, such as in the SCOLA project, we achieved an urban virtual environment generation system based on Open Street Map data such as maps and several information layers. These geographical, geometrical and informational data are processed in our system to provide 3D shapes and semantic data that will be exploited later in the scenario generation process.

A second step in serious game design is to define a gameplay well fitted to the knowledge transfer according to the chosen pedagogical process. Some help can be found in serious game characterization and classification according to both “serious-related” and “game-related” characteristics (Djaouti, Alvarez &

Jessel 2011). At the gameplay design level, a classification was also proposed (Djaouti, Alvarez, Jessel, Methel & Molinier, 2008) which was relying on "Gameplay bricks" whose combinations cover the various gameplay of videogames. Nevertheless, the total number of "combinations" obtainable through these bricks remains quite large. Interestingly enough, we noticed that some couples of bricks ("Metabricks") were identified very often in a large number of games. These activity bricks can be very useful when defining interaction and animation capabilities to associate them to objects or characters behavior.

At last, the main issue in serious game design consists in building a learning scenario with pedagogical objectives (Alvarez & Djaouti, 2011) (Garris, Ahlers & Driskell, 2002). After described the activities and the pedagogy, the serious game designer connects them in the pedagogical scenario in order to model the pedagogical feedback the learner will receive while they play a training session in the virtual environment. In the domain of virtual environment modeling, previous works have already been carried out to allow serious game designers to build and set up pedagogical scenarios following the same methods. Existing textual modeling languages have been used to describe and orchestrate virtual environments. (Ishida, 2002) has extended the Scheme language to describe interaction scenarios between agents in a 3D environment. A specific grammar, designing a textual language, can be used to manage agents in a virtual world (Devillers and Donikian S., 2003). XML (Extensible Markup Language) or JSON (JavaScript Object Notation) can also be used to describe objects behavior in a virtual environment (Tang, S., Hanneghan M., & Carter C., 2013).

As future development, we want to achieve a scenario generation method based on semantic data issued from the virtual environment provided by the modeling step thanks to procedural modeling methods. Linking scenario bricks with 3D modeling can be achieved through mechanisms such as smart objects (Kallmann, 2001) affordance setting (Gibson, 1977) or semantic modeling (Finkenzeller Bender, 2008). Our scenario description and building method will be based on configurable building blocks (Van Est, Poelman & Bidarra, 2011) as scenario description basis, combined with BPMN (White, 2004) (Panzoli, Sanselone, Sanchez, Sanza, Lelardeux, Duthen & Lagarrigue, 2014) and activities diagram notations (Buche, Bossard, Querrec, & Chevaillier, 2010). Thus, semantic modeling could be a very effective solution for the virtual environment generation (Zaragoza Rios, 2009) for two main reasons: first because it has to handle the different ways to define an entity or a concept, from its physical appearance to the list of its attributes, parts or elements, not to mention the correct analysis of the sentences by the system in order to keep coherence in the scenario. Second because it responds to the user's demands of creating a personalized world in the game, and thus enhances his immersion in the game play.

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