Virtual World Builder Toolkit

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ABSTRACT

In this paper we present a system that automatically generates a 3D virtual world from a virtual institution (VI) specification, namely of activities that will take place in the virtual world. A virtual institution is an interaction environment where both human and software agents participate in a joint 3D virtual world. A VI is visualized as a 3D building composed of rooms representing the different activities defined in its specification. To support the generation of the 3D scene, we propose an extension of shape grammars called virtual world grammar (VWG). A VWG incorporates information about the definition of the activities, properties of the different shapes (i.e spaces), functions to evaluate and validate the generated design, and a set of heuristics to guide the generation process. A definition and execution of Virtual World Grammars and a 3D transformation mechanism are integrated in a so called Virtual World Builder Toolkit (VWBT).

Categories and Subject Descriptors

I.2.11 [**Distributed Artificial Intelligence**]: Multiagent systems; H.5.1 [**Multimedia Information Systems**]: Artificial, augmented, and virtual realities

General Terms

Algorithms, Management, Design

Keywords

Shape Grammars, Virtual Institutions, 3D Virtual Worlds

1. INTRODUCTION

In recent years, ever-increasing advances in both 3D computer visualization and artificial intelligence technologies have increased demand for applications where human and software agents can participate and interact. Multi-agent systems view is appropriate to design such applications. However, up until now only few efforts have been devoted to human participation (incorporation) into MAS. One of the few works dealing with such an issue are *virtual institutions* (VI)[1]. They are 3D Virtual Worlds with normative regulation of interactions. In this paper we present the Virtual World Builder Toolkit a tool that gives support to the automatic generation of a virtual world from a VI specification. The video[1] demonstrating the possibilities of the tool and the software binaries and source code[2] are publicly available.

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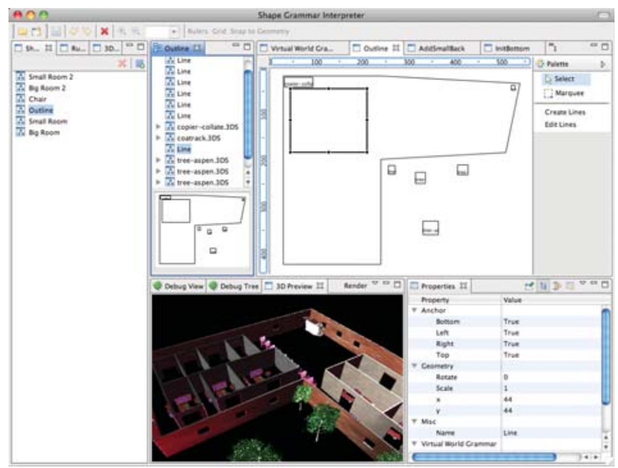

Figure 1: Interface of Shape Grammar Interpreter with Virtual World Builder Toolkit Extensions

2. VIRTUAL WORLD BUILDER TOOLKIT

The *Virtual World Builder Toolkit* (VWBT) includes a set of algorithms and user interfaces to support the generation of 3D Virtual Worlds for the execution of Virtual Institutions. In such a process, it first generates the 2D floor plan from the Virtual Institution specification that defines the activities participants can engage on. Later, our system uses a 3D transformation module to generate a final 3D scene from the 2D floor plan. VWBT is built as an extension plugin for our Shape Grammar Interpreter (SGI) [3]. A Figure 1 show the interface of the SGI tool with the Virtual World Builder Toolkit plugin. The tool is developed in Java to be platform independent. We use Eclipse RCP and GEF frameworks to give the user a comfortable experience and to provide future programmers the possibility of extending current functionality using well known and well supported frameworks.

[1] http://www.iiia.csic.es/∼ttrescak/vwbtsmall.html
[2] http://sourceforge.net/projects/sginterpreter/

2.1 Floor plan generation

Our technology relies on *shape grammars* which are production rule systems that generate geometric shapes or designs [2]. A pure shape grammar holds only basic geometric information. Therefore, to produce a 2D floor plan based on activities defined in a MAS and which can be later transformed into 3D, we need additional *semantic data* (metadata). Furthermore, we need to control the generation process and validate it, in order to build viable layouts (e.g. without intersecting rooms, a big enough room to acommodate all participants). Thus, we propose an extension of shape grammars called *Virtual World Grammar (VWG)*. It describes all the elements that take part in this process (*ontology*, *shape grammar* and *element instances*), establishes rules on how these elements are processed (*heuristics*) and it gives the possibility of evaluating the running process (*validations*).

The *Ontology* consists of both shape grammar and specification concepts. For the specification concept we define the *activity* concept which holds parameters from VI specification (e.g. number of participants). Shape grammar *concepts* are *block, space and wall*. A *Shape grammar* represents the logical graphical layout of rooms and structures. An example of such shape grammar is provided in Figure 2. *Heuristics* in this example simply return first not executed specification element (representing some activity) from the list of all specification elements. The *Validation* set in this example only includes one validator that is executed after each execution step and that validates if the added element intersects with already situated element.

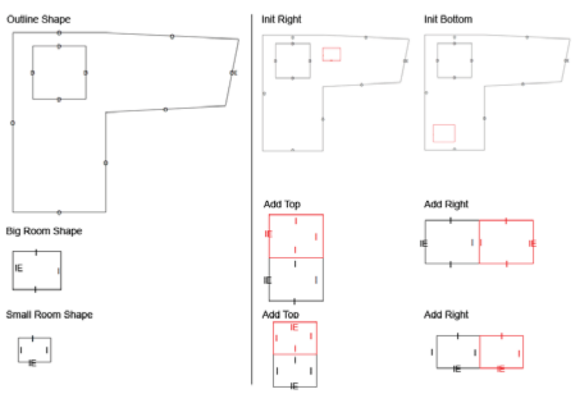

Figure 2: Simple shape grammar for floor plan generation

The use of shape grammars brings possibilities of generating different designs and explore the design space to select the best design. An example of generated 2D floor plan layout of virtual institution can be seen in Figure 3a). The size of each generated room depends on the maximum number of participants of the activity it represents. Such data are extracted from the specification. Grammars can be combined in an iterative process and modified accordingly to bring the best results. When such desired output is produced, we can run the 3D transformation module to generate the 3D representation of the current floor plan.

2.2 3D Transformation Mechanism

A 3D transformation mechanism uses the generated 2D floor plan and in combination with semantic informations stored in the VWG renders the final model. Some objects, such as walls are procedurally generated. These walls are rendered with doors which are used to enter and exit spaces. Windows are also generated for decorative effect. Other objects, represented by placeholders are substituted by 3D models to be used either as functional or decorative objects. We use jMonkeyEngine to create the final model. jMonkeyEngine allows us to directly load the generated 3D scene into Wonderland, which is Sun Microsystem's virtual world. A generated floor plan and 3D model generated by 3D transformation of this floor plan are depicted in Figure 3.

a) Floor plan b) 3D render

Figure 3: An output of the Virtual World Grammar

3. CONCLUSIONS

We have presented the VWBT which supports the generation of a 3D Virtual World from a Virtual Institution specification. It allows designers to browse the design space and to select those 2D layouts that we want to transform into 3D space. The 3D transformation module loads this 2D representation, combines it with information stored in the Virtual World Grammar and generates the final 3D scene. To support this process we have presented an extension of shape grammars called Virtual World Grammar. Currently we are working on a more automated way to populate the 3D space with non-functional objects, such as furniture to produce immersive environments.

4. ACKNOWLEDGMENTS

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