Generating 3D Virtual Environments Using The Virtual World Builder Toolkit

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Abstract Hybrid systems such as those that combine 3D virtual worlds and organization based multiagent systems add new visual and communication features for multi-user applications. In this paper we present a tool called Virtual World Builder Toolkit (VWBT) that can automatically generate a 3D virtual worlds (VW) from an organization based multiagent system (MAS) specification that establishes the activities participants can engage on. This tool provides a comfortable definition and execution of Virtual World Grammars (VWG) which are an extension of shape grammars to support the generation of virtual world designs.

1 Introduction

In recent years, ever-increasing advances in both 3D computer visualization and artificial intelligence technologies have increased the demand for applications where human and software agents can participate and interact [1]. The construction of such a 3D virtual world using a traditional authoring system i) is a time consuming task for designers and ii) makes it almost impossible to manage the dynamic update of the virtual

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world design at runtime. The latter issue is crucial for us as we are interested in the dynamic nature of VWs. Then, we need a powerful method to generate and update 3D virtual scenes in an automatic way.

In this paper we present the Virtual World Builder Toolkit, a tool that gives support to the automatic generation of a virtual world design from a multiagent system specification. The video[1] demonstrating the possibilities of the tool and the software binaries and source code[2] are publicly available.

2 Virtual World Grammar

Virtual World Grammar is our proposed mechanism to support the automatic generation of Virtual Worlds from the specification of the activities taking place there. It is an extension of shape grammars introduced by Stiny and Gips [2]. Shape grammar contains geometrical information about shapes but it does not contain any semantic information about them. Virtual World Grammar overcomes this limitation and introduces new execution and validation mechanisms. A VWG includes four components: an ontology, a shape grammar, heuristics and validations. The **ontology** consists of both shape grammar and specification concepts. For the specification concept we define the activity concept which holds parameters from multiagent system 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. **Heuristics** guide the process of world generation. They have two important roles. First, to decide

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[1] http://www.youtube.com/watch?v=0fQ-i17FnZ4
[2] http://sourceforge.net/projects/sginterpreter/

in which order to process the elements from the specification. Second, how to find possible execution nodes in the execution tree for currently selected specification element. **Validations** provide a mechanism for testing and evaluating the execution of a shape grammar. Step validations provide control mechanisms for shape grammar execution so that no invalid path of execution is selected (e.g. test for correct placement of rooms so the walls do not cross). Final validations serve for evaluating the final design.

3 Virtual World Builder Toolkit

The Virtual World Builder Toolkit (VWBT) provides visual interfaces and mechanisms to define and execute Virtual World Grammars in a user-friendly way. The toolkit loads the specification of a multi-agent system and using VWG data entered through the user interface generates the 3D world. It is integrated in our Shape Grammar Interpreter (SGI) [3]. SGI is a complete and robust tool that allows the user to comfortably specify any shapes and rules and also have complete control over grammar generation process. It is a platform-independent tool with ability to create and process any shape grammar with full support of labeled rules and subshape detection.

Figure 1 shows the interface of SGI along with VWBT extensions. Part 1 of this figure shows a list of shapes and rules. Part 2 along with part 3 form the editor part where user can define and modify any parts of the VWG. Shape grammar parts are easily modified by mouse or entering the values through the property view in part 5. Part 4 is the 3D preview of the currently generated floor plan. An intermediate output of the generation process is a floor plan of the virtual world, which is later transformed into a 3D model.
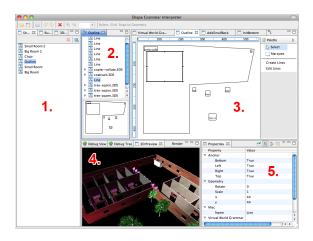
Fig. 1: SGI interface with WVBT extensions

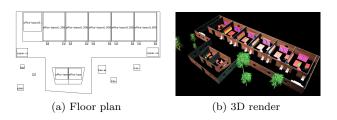(a) Floor plan   (b) 3D render

Fig. 2: A simple output of the VWG

An example of the VWBT output is shown in Figure 2. The presented solution allows to (i) dynamically react to changes in the specification and simply regenerate the adapted virtual world (ii) separate artistic (graphical) design of the institution from the functional implementation (iii) make generation process transparent to institution designer and 3D virtual world designer and (iv) browse design space and easily explore possible designs. Grammar designer can either browse possible designs or modify existing parts of the shape grammar to obtain satisfiable results.

4 Conclusions

We have presented a virtual world grammar for the automatic generation of 3D virtual worlds in which inhabitants can be both humans and agents. We have also presented the Virtual World Builder Toolkit that provides a user-friendly interface allowing a comfortable definition and execution of virtual world grammars. An important feature of the VWG is that the user can explore many different designs or modify existing parts of the shape grammar to explore new designs. We plan to apply our methodology in computer games domain, namely in MMOG.

References

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