

Procedural Modeling of Cities implemented as a Blender Plugin

Project Proposal

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Background:

One of the major areas of research in computer graphics, because of its uses in the entertainment industry and virtual reality fields, is the concept of procedural modeling. This is the process of generating 3D models and scenes with minimal user input such as a basic set of parameters. This project will aim to provide an extension to an existing procedural modeling project which is currently underway in the Computer Science department of Rhodes University. "Text To Scene" is a project which looks to generate through procedural methods 3D scenes and environments based on textual input. The eventual results of this project are hoped to be the procedural generation of visual scenes based on the input from novels or other books. As a part of this project however various auxiliary plug-ins and extensions are required. An extension to this project is the implementation of a solution to perform procedural modeling of urban environments and cities. In this subsection of procedural modeling, attempts have been made to generate large scale realistic urban environments without having to manually model each individual building and road. This solution should then be implemented as a plug-in for the 3D modeling package Blender in accordance with the requirements of the "Text To Scene" project. An existing plug-in for Blender was developed by Mole [2004], however this plug-in does not meet the specific requirements of the "Text To Scene" project, specifically it requires far more input from the user than the Text To Scene system would allow. Thus a new plug-in based on more restricted procedural methods is required.

The problems to be addressed:

The problem includes the automatic generation of a road map layout and the extrusion of actual building shapes which are both detailed and non-uniform. This project will be looking to implement an efficient and effective procedural modeling method for city generation. This

includes the development of a complex road network and complex shaped buildings, similar to what is described by Parish and Müller [2001]. Buildings in particular will follow the work of Heagler et al. [2006]. Finally an implementation of this framework must be created, for this problem the open source 3D Modeling package Blender will be used. The specific implementation will have to conform to various constraints which are enforced by the Text To Scene system. This will mean that the implementation will have to generate cities with minimal user input but must also be able to conform to specific constraints such as the prior existence of objects in the scene which would restrict the placement of roads and buildings. These constraints could range from simple statements such as “do not place anything within these co-ordinates” to complex constraints such as the existence of landscape objects like rivers or mountains which will directly affect the road layout and building types. One of the major aims of this system will have to be the implementation of a procedural model which can work from almost no input data to one which can receive various complex parameters and implement them whilst avoiding any graphical inconsistencies.

Intended Approach:

The overall structure of this project will be based around dividing the requirements into six specific sections. Firstly the project requires the algorithmic implementation of a specific road map implementation. To achieve this the initial implementation of the road network will be in OpenGL, this will allow for effective optimizations and enhancements to the algorithm itself before having to complicate the project with the specific Blender implementation. The second task will be to implement and fine tune the algorithm for building generation in OpenGL, this will again allow for effective refinement of the algorithm before the complication of the Blender implementation. The third major milestone of the project will be to develop a generic Blender plug-in, allowing for a greater understanding of the processes involved in Blender plug-in creation. Steps four and five will involve the actual implementation of the two algorithms into Blender itself and the early development of the plug-in. Finally the sixth goal of the project will be the proper creation and refinement of the Blender plug-in to allow for specific parameterization as required by the Text To Scene system. The compartmentalization of the project into these specific steps will allow for sufficient development of each phase without running the risk of the project becoming bogged down with simple implementation issues before any results are achieved. A guideline to the intended approach is provided below.

First Semester:	Duration:	Proposed Dates:
Term One:		
Study of Relevant Background Material and Papers	2 weeks	26/02/07 - 09/03/07
Preliminary decision of Road Generation Method	n/a	23/03/07
Presentation of Project Proposal	n/a	13/03/07 or 20/03/07
Implementation of Road Generation in OpenGL	4 weeks	05/03/07 - 30/03/07
Term Two		
Preliminary decision of Building Construction Method	n/a	16/04/07
Implementation of Building Construction in OpenGL	4 weeks	16/04/07 - 11/05/07
Preparation of Literature Review	4 weeks	30/04/07 - 28/05/07
Familiarization with Blender scripting	2 weeks	14/05/07 - 25/05/07
Implementation of Road Creation in Blender	4 weeks	21/05/07 - 15/06/07
Submission of Literature Review	n/a	28/05/07
Second Semester:		
Term Three:		
Implementation of Building Creation in Blender	4 weeks	23/07/07 - 17/08/07
Oral Presentation of project progress	n/a	24/07/07 or 31/07/07
Code Inspection	1 week	06/08/07 - 10/08/07
Creation of Blender Plug-In	3 weeks	20/08/07 - 07/09/07
Poster Presentation	1 week	20/08/07 - 24/08/07
Begin Thesis Write-Up	5 weeks	27/08/07 - 01/10/07
Term Four:		
Draft Paper Hand In	n/a	17/09/07
Skeleton Outline of Thesis Hand In	n/a	17/09/07
Implementation of Further Optimizations	2 weeks	17/09/07 - 28/09/07
Final Paper Hand In	n/a	25/09/07
Final Structure of Thesis hand in	n/a	25/09/07
Chapter Drafts Handed In	n/a	01/10/07
Final Oral Presentation	1 week	29/10/07 - 02/11/07
Final Project Hand-In	n/a	05/11/07

Initial Survey of Resources and Literature:

Procedural Modeling of Cities is a large and diverse subject with many contributing authors and resources, a few of the most pertinent resources have been selected and described below:

Procedural Modeling of Cities [Parish and Müller, 2001]. This paper has specific relevance to the road generation algorithms. Specifically it details the differences between various road layouts and the algorithms and methods that best apply for generating each. The paper also covers the basics of building generation and texturing.

Procedural Modeling of Buildings [Haegler et al. 2006]. This paper will supplement the first as a basis for this project, it looks specifically at optimized procedural methods for building generation. This paper supersedes the building generation methods used in [Parish and Müller, 2001] and thus will be of direct relevance to the building generation section of this project.

Instant Architecture [Ribarsky et al. 2003]. This paper provides further insights into the process of building generation and texturing. It looks at algorithms for creating varied and realistic buildings using split grammars.

Real-time Procedural Generation of 'Pseudo Infinite' Cities [Greuter et al. 2003]. This paper presents an approach to generating virtual cities in real-time, focusing on a square grid pattern of roads.

Expected Results:

The aim of this project is to develop a functioning plug-in for the Blender modeling package. Thus the expected results would be a plug-in which could be invoked either through the graphical user interface or as a part of a Python script written for Blender. This plug-in will then generate the geometry for a city model based on the constraints provided by the Text To Scene system.

Possible Extensions:

The scope of this project will only allow for a limited range of cities to be developed, further extensions could include parameterization which allows the user to decide on such variables as the genre of the city, say turn of the century London, or the major industry of the city, say mining. With this extension the plug-in could alter building types, densities and appearance to conform to the users requirements.

References:

GREUTER, S., PARKER, J., STEWART, N., AND LEACH, G. Real-time procedural generation of 'pseudo infinite' cities. In *GRAPHITE '03: Proceedings of the 1st international conference on Computer graphics and interactive techniques in Australasia and South East Asia*, pages 87–94. ACM Press, 2003.

HAEGLER, S., MÜLLER, P., ULMER, A., WONKA, P., AND VAN GOOL, L. 2006 Procedural modeling of buildings. In *proceedings of ACM SIGGRAPH 2006*, ACM Transactions on Graphics 25, ACM Press, 614 – 623.

MOLE, A. Procedural City Detailing, *Honours Thesis*, 2004.

PARISH, Y. I. H., AND MULLER, P. Procedural modeling of cities. In *Proceedings of the 28th annual conference on Computer graphics and interactive techniques*, pages 301–308. ACM Press, 2001.

RIBARSKY, W., SILLION, F., WIMMER, M., AND WONKA, P. Instant Architecture. *ACM Transactions on Graphics*, 22(3):669 – 667, 2003.