Chapter 2
Procedural Virtual Worlds

Nuno Rodrigues
Polytechnic Institute of Leiria, Portugal

Luís Magalhães
University of Trás-os-Montes e Alto Douro, Portugal

João Paulo Moura
University of Trás-os-Montes e Alto Douro, Portugal

Alan Chalmers
University of Warwick, UK

Filipe Santos
Polytechnic Institute of Leiria, Portugal

Leonel Morgado
University of Trás-os-Montes e Alto Douro, Portugal

ABSTRACT

With the increasing demand for more complex and larger models in different fields, such as the design of virtual worlds, video games, and computer animated movies, the need to generate them automatically has become more necessary than ever. Manual tools are no longer sufficient to match this rising need, and the impact that automatic tools may have within these fields is essential and may lead to an adoption of virtual worlds in a growing number of applications. Indeed, it is possible to eliminate most of the effort associated with the creation of such environments, by providing tools that may generate ‘massive’ 3D content automatically. In consequence these tools may lead to an exponential growth of virtual environments and represent an important turn into the design of realistic virtual cities, which may have a huge impact on virtual world users. This chapter discusses the very complex issue of where and when procedural modelling may be used and presents some solutions and methods that have been successfully used in the aforementioned fields of application.

INTRODUCTION

The continuous trend to use virtual worlds coming from several different domains, such as education and private sectors, leads to the need to efficiently create virtual environments. Indeed, in virtual worlds as well as in the competitive markets of film, video games and several other applications, there is a trend to rapidly produce digital content at low costs. Manually designing virtual environments, during long periods of time, is not a cost effective solution with limited valuable human resources in many situations.

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Within the present context, procedural modelling represents an effective solution to produce digital content which is, in numerous virtual worlds, often characterized by urban environments. In order to assure the realism of the final models there is the need to account for many architectural concerns. These are essential aspects when dealing with different applications, such as heritage worlds amongst others. The increasing number of virtual world users from diverse areas creates the need to provide tools, able to efficiently produce realistic urban environments featuring traversable structures (e.g. houses), which achieve architectural coherence.

Traditionally procedural modelling have been used mostly in film and games and is not, yet, a mainstream solution for the design of 3D content for virtual worlds, such as Second Life, Active-worlds or Croquet. It is a fact that some virtual worlds (e.g. Second Life) have well known native modelling tools, but these are not yet procedural. Some small procedural plug-ins do exist, often designed only to fulfil small specific requirements, such as the creation of textures. For these reasons, the next sections describe in which worlds may these procedural techniques and tools may be adopted and when and how it may be done. This chapter is mostly centred on the creation of urban environments, one of the targets of procedural modelling. Most virtual worlds, such as virtual worlds for socialization purposes, are often characterized by these type of models. The automatic content creation that can be achieved with such tools may deal with different features, such as the generation of clouds and textures, streets and roads, vegetation, houses and many other objects. These content generation have been used mainly in film and game industry but most of this features are often present in virtual worlds and may used in these in a similar way.

This chapter starts by presenting an overview of procedural modelling. Then the dilemma behind where, when and how should procedural modelling be used in virtual worlds is addressed. This is followed by a discussion of two possible targets of procedural modelling: reconstruction and generation. After that, some tools and techniques are described and finally some conclusions and future trends presented.

“GOING PROCEDURAL”

In the last few years, the use of algorithms to automatically generate virtual reality environments has become an effective solution for the production of digital content. In fact, the idea of automatically recreating environments with very little modelling effort is a fascinating idea that can lead to several benefits in different areas including virtual worlds (a few other examples include architecture, video games and movies). The goal is to place all, or most of the effort, of creating an environment in computer software. This means that the time spent by human resources, such as computer modellers or even a plain virtual world user who wants to create their own models, would be significantly reduced and their time may be used on more useful tasks.

The creation of virtual environments via an algorithm (instead of manually) is often identified as “generation” of virtual environments. Similarly, the set of techniques which rely on algorithms to generate these environments are often referred to as “procedural modelling” techniques. Although there are diverse techniques used in procedural modelling, such as grammar based techniques (e.g. L-systems1), fractals2 and generative modelling3, the general purpose of these is similar: apply parameterised algorithms to produce 3D virtual scenes. The result is to create 3D models or textures from user choices rather than manually modelling each of the environment features.

Procedural modelling techniques embody essential tools, in situations where it would be cumbersome to create 3D models manually, or where current software does not provide efficient means to produce those models. One particular
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