Chapter 5

3D Mesh Model Coding

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ABSTRACT

Application of 3D mesh model coding is first presented in this chapter. We then survey the typical existing algorithms in the area of compression of static and dynamic 3D meshes. In an introductory sub-section we introduce basic concepts of 3D mesh models, including data representations, model formats, data acquisitions and 3D display technologies. Furthermore, we introduce several typical 3D mesh formats and give an overview to coding principles of mesh compression algorithms in general, followed by describing the quantitative measures for 3D mesh compression. Then we describe some typical and state-of-the-art algorithms in 3D mesh compression. Compression and streaming of gigantic 3D models are specially introduced. At last, the MPEG4 3D mesh model coding standard is briefed. We conclude this chapter with a discussion providing an overall picture of developments in the mesh coding area and pointing out directions for future research.

INTRODUCTION

The development of compression algorithms for static meshes was mainly forced by the community of 3D graphics hardware accelerators. The goal is to reduce the amount of bytes that need to be transferred from the main memory to the graphics card. The compression of such huge static meshes not only increases the rendering performance but also decreases the storage cost at hard discs. Modern scanning devices are able to produce huge point clouds which are converted to extremely big triangle soups by surface reconstruction algorithms. For example, the biggest model consists of several 10⁹ polygons, which can occupy a whole PC hard-disk. Furthermore, the transmission of static meshes over networks becomes important for applications like virtual shopping malls. In addition, efficient storage and broadcasting of dynamic 3D content gets crucial...
importance for commercial success of 3DTV technology. Dynamic 3D objects in their generic form represented as a sequence of static meshes require even multiple of times more storage than a single static mesh. As a result, a variety of algorithms have been proposed that work well for both static and dynamic meshes.

Interactive 3D graphics plays an important role in various fields such as entertainment, manufacturing and virtual reality. When combining the graphics technology with the Internet, the transmission delay for 3D graphics data and the high storage capacity requirement are becoming major performance bottlenecks, especially for the gigantic meshes consisting of tens of thousands of triangles. Thus reducing the amount of data is, go without saying, an effective solution. Consequently, interests in techniques for the 3D geometry data compression and streaming have surged in recent years.

Although many representation methods for 3D models exist, the triangle is the basic geometric primitive for standard 3D graphics applications, graphics rendering hardware and many simulation algorithms, while any other surface representations can be easily converted to triangle meshes. Triangle meshes are composed of two components: vertex data and connectivity data. Vertex data mainly include the positional coordinates of the vertices and, optionally, some other attributes. The connectivity data specify which vertices are connected.

By reading this chapter, the readers are expected to acquire the basic knowledge of 3D model, the basic concept of 3D mesh model codec, and the ideas of the state-of-the-art algorithms for 3D model coding and streaming.

**BACKGROUND**

In this section, we will introduce you some basic knowledge of 3D model, including 3D modeling, data representations, 3D model formats, 3D data acquisition, 3D data display, 3D mesh model coding basics, and 3D mesh model quality assessment.

**3D Modeling and Data Representations**

What we call 3D modeling, is to use 3D data to reconstruct 3D objects or scenes of the real world in computers, and finally to simulate real 3D objects or scenes in computers. 3D data is sampled by various 3D data collectors, and include various physical parameters on discrete points on finite object surfaces. The basic information 3D data include are 3D coordinates of each discrete points of objects, and optionally colors, transparency, texture features, and etc. on surfaces of objects. 3D modeling play important roles in the fields of architecture, medical images, 3D graphic games, film trick design and so on. In the field of architecture, if we represent a building using common 2D pictures (e.g., photos), it is not convenient to observe some detailed parts or inside structures. Although blueprints of the building include abundant information, they are not easy to understand and not intuitional for nonprofessional clients. However, if we reconstruct the 3D model of this building using 3D modeling techniques, we can directly observe different aspects, whole structure and even interior structure of this building, which is convenient for the purposes of both architects evaluating the design effect and observation of clients. In the field of medicine, people always lay siege to 3D human-being vivisection drawing. Institute of medical mathematics and medical computer in Hamburg University in Germany have carried out a project of 3D visualization of vivisection named “Voxel-Man”. Using the tools of “Voxel-Man”, doctors can simulate the processes of surgical, solid location and punch. Virtual surgery is another example of application of 3D modeling in medicine. Biomedicine image processing resource center of the well-known proprietary hospital in USA have developed and designed a 3D interactive surgery assistant sys-
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