Chapter 24
Methods of 3D Object Shape Acquisition

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ABSTRACT

This chapter contains an overview of methods for a 3D object shape from both the surface and the internal structure of the objects. The acquisition methods of interest are optical methods based on objects surface image processing and CT/NMR sensors that explore the object volume structure. The chapter also describes some methods for 3D shape processing. The focus is on 3D surface shape acquisition methods based on multiple views, methods using single view video sequences, and methods that use a single view with a controlled light source. In addition, the volume methods represented by CT/NMR are covered as well. A set of algorithms suitable for the acquired 3D data processing and simplification are shown to demonstrate how the models data can be processed. Finally, the chapter discusses future directions and then draws conclusions.

INTRODUCTION

3D object construction is one of the key issues of computer graphics and its applications both historically and at the present time. 3D object model representation in computers is the key information in 3D computer graphics, computer vision, and other fields of applications. The 3D models can be obtained through one of the two fundamentally different processes – creation of synthetic models and acquisition through measurement of real existing models. Also, combination of the processes is possible. While the first of the processes, creation of synthetic models, is addressed through many 3D editors, CAD systems, etc. and can be seen as relatively mature (Computer-aided design,

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2010; Farin et al., 2002), this chapter focuses on the second approach – acquisition of the models through measurement of real existing models or structures.

The importance of 3D models for computer graphics is given by its fundamental purpose – manipulation and rendering of the models. The importance for other fields of computer science and applications can be different but often includes validation of hypotheses (e.g. in computer vision), planning (e.g. in robotics), representation of knowledge (e.g. in machine learning), etc.

Many definitions of the data structures for the 3D model representation exist and are being used. These definitions can generally be categorized as volume representations, surface representations, and point cloud representations (Foley et al., 1995). At the present time, the most frequently used for rendering purposes are surface representations and point cloud representations that share the property of consisting of a set of precisely positioned points in 3D space, possibly defining the position and shape of planar or non-planar surface elements. The acquisition process often leads in different data structures and in many cases, the acquired data model must be processed for further exploitation. Such processing typically includes conversion into another 3D model representation and simplification.

BACKGROUND

The recognition of 3D shapes through measurement of the existing scenes and through processing of sensory information is a complex task. Description of all the approaches used and attempted would be beyond the scope of this text. The main approaches used today are overviewed and explained here. Nowadays, the main approaches include:

- Getting 3D coordinates from images or video of the scene – this approach is interesting as it is intended for acquisition of 3D scenes based on image and video information only without any other source of (sensory) information. Therefore, it can also be seen as means of acquisition of the 3D scene from image data sensors that are generally available and that exploit arbitrary data (Kraus, 2000; Koch, 1995; Pollefeys et al., 1998).
- Obtaining 3D data from specialized image sensors – the approach based on images but using specialized light sources. While this approach requires specialized sensor setups, it might be simpler, less expensive and also more precise compared to the above methods (Zhang, 2005).
- Processing other than image sensors to get 3D data – a typical example of such an approach can be seen in medical imaging where 3D models of tissues are obtained through CT and/or NMR data that are in their nature not image data but still can carry information about the 3D scene (Vivodtzev et al., 2003; Du & Wang, 2003; Labelle & Shewchuk, 2007).
- Other methods of getting 3D data - such as measurement of the scenes through various distance measurement devices, fusion of the information from different types of sensors, etc. These approaches are beyond the scope of this text.

The data obtained through the methods mentioned above do not necessarily fulfill the requirements of the application for which it is intended. Therefore, postprocessing of the data often needs to be done. The postprocessing can include conversion of the data representation, reduction of data size, ensuring integrity of the data, etc. This text outlines an overview of the approaches in order to give the reader further insight in this area.