

Chapter 3.17

VRMiner: A Tool for Multimedia Database Mining with Virtual Reality

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ABSTRACT

We present in this chapter a new 3D interactive method for visualizing multimedia data with virtual reality named VRMiner. We consider that an expert in a specific domain has collected a set of examples described with numeric and symbolic attributes but also with sounds, images, videos and Web sites or 3D models, and that this expert wishes to explore these data to understand their structure. We use a 3D stereoscopic display in order to let the expert easily visualize and observe the data.

We add to this display contextual information such as texts and small images, voice synthesis and sound. Larger images, videos and Web sites are displayed on a second computer in order to ensure real time display. Navigating through the data is done in a very intuitive and precise way with a 3D sensor that simulates a virtual camera. Interactive requests can be formulated by the expert with a data glove that recognizes the hand gestures. We show how this tool has been successfully applied to several real world applications.

INTRODUCTION

Since Fisher's work on Iris database (Fisher, 1936), and thanks to possibilities given by computers, data representations have evolved and become much more complex. In many domains, databases are not only compounded of numeric or symbolic attributes but may also be enriched, for instance, by sounds, images, videos, texts, Web sites or 3D models. The main focus of this chapter is on helping the domain expert to intuitively analyze such data sets.

In our opinion, intuitive analysis of a multimedia database implies the use of visualization and virtual reality techniques, a subset of the visual data mining (VDM) domain. VDM is a growing field of research in data mining (DM) and knowledge discovery in databases (KDD). VDM relies on the fact that the human brain efficiently deals with visual perception and can quickly extract a lot of information and knowledge from a scene. Visualization of data is an important step in DM and KDD, either at the beginning, during or end of the knowledge discovery process (Fayyad et al., 1996); before knowledge extraction, visualization may be useful as a preprocessing step which helps the user to better understand the data set. Visualization can also be used during the KDD process for discovering an efficient classifier. Once knowledge has been discovered, the expert often needs to interpret it in order to take a decision, and visualization techniques can help to represent this knowledge as well. Therefore, most of the DM/KDD tools and applications can be concerned with VDM.

Virtual reality (VR) proposes significant advances in the domain of data visualization as well as user interaction. Virtual worlds can be built by combining an advanced display, sensors and actuators. VR displays are 3D and stereoscopic; sensors may detect the user's moves. Actuators with feedback forces may simulate more efficiently the effects of actions. VR makes the human-computer interaction very intuitive, and this is our motiva-

tion for integrating VR in VDM. The remainder of this chapter is organized as follows: the *State of the Art* section presents a survey of VDM and VR; *Exploring/Understanding Multimedia Data* describes our approach for interactive exploration of multimedia data; *Results* presents the results obtained on benchmark and real data; and the *Conclusion* section concludes on the perspectives which can be derived from this work.

STATE OF THE ART

Data Visualization

Data visualization techniques are numerous. They may be classified according to several criteria. One common criterion is the data type that is visualized (Schneiderman, 1996) as documents in the domain of information retrieval (Zamir, 1998), numerical data (Wong & Bergeron, 1997), hierarchical data (Lamping et al., 1995) or geographical data (Schumann & Urban, 1997). Visualization techniques may also be grouped according to the type of display they use: 1D, 2D, 2.5D or 3D (Cugini et al., 2000), and on how they draw the users attention (Wises & Carr, 1998). These techniques may also use metaphors, such as a book or a room (Card et al., 1996), a map (Wise et al., 1995) or a city (Sparacino et al., 1999).

We focus in this chapter on 3D representations (Wises & Carr, 1998). The use of a 3D display may greatly improve the comprehension of the data (Ware & Franck, 1994), but it also has drawbacks (see *Guidelines* section).

Visual Data Mining

As mentioned in Wong and Bergeron (1997), the exploratory analysis of data and VDM are not just a set of tools but rather a philosophical way of solving KDD problems. Two important points can be highlighted in VDM: the perception of the data and the interaction with the data repre-

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