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Chapter XV

Methods for Dealing with Dynamic Visual Data in Collaborative Applications– A Survey

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Many important collaborative applications require the sharing of dynamic visual data that are generated from interactive 3D graphics or imaging programs within a multimedia environment. These applications demand extensive computational and communication costs that cannot be supported by current bandwidth. Thus, suitable techniques have to be devised to allow flexible sharing of dynamic visual data and activities in real time. This chapter first discusses important issues that need to be addressed from four perspectives: functionality, data, communication and scalability. Current approaches for dealing with these problems are then discussed, and pertinent issues for future research are identified.

INTRODUCTION

Much work has been devoted to the development of distributed multimedia systems in various aspects: storage, retrieval, transmission, integration and synchronization of different types of data (text, images, video and audio). However, such efforts have concentrated mostly on passive multimedia material which had been generated or captured in advance. Yet, many applications require active data, especially 3D graphics, images and animation, that are generated by interactively executing programs during an ongoing session of a multimedia application. For example, a user of an educational multimedia system may wish to simulate and analyze the behaviour of a scientific or economic phenomenon by varying the values of variables or parameters in application programs in order to view the effects. Similarly, a medical practitioner may wish to perform some image manipulation and

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processing in a specific manner to illustrate certain ideas to colleagues during a cooperative diagnosis or consultant session. A common practice is to generate graphical or image outputs for each instance in advance, and store and recall them for display as required. A more effective way to gain some insight would be to allow the user to run the programs on the fly and to change the values of the parameters at will or to select the values according to the results of previous runs. Such activities also need to occur in real time. The main obstacle to this mode of usage is the limitation of current network bandwidth which does not allow large amounts of graphical or image data to be transmitted in real time. This problem exacerbates if such a multimedia system is to be operated in a collaborative environment where a number of participants wish to share the knowledge by running programs with different parameters and discuss results with each other.

While the boundary between computer graphics and image processing or analysis was traditionally strong, recent progress has gradually blurred this distinction as many techniques used in one area have been adapted for the other. In addition, some applications require both of these types of data and tasks. For example, some medical applications need both 2D digital images in various modalities (X-ray, MRI, PET, etc.) and volumetric data (e.g., 3D models of anatomical parts to aid surgery). A virtual environment such as a virtual museum may be constructed by combing 3D graphical modeling with the montage of 2D digital images. A visualization and analysis system for supporting mineral exploration requires the capability of both 3D geological modelling and processing of satellite images of terrains. Thus, it is pertinent to deal with both these types of tasks and data. Within the context of this chapter, we use the term 'visual data' to denote both digital images and graphical data, and discuss them together if the matter is applicable to both while pointing out the differences whenever appropriate.

Computer-supported cooperative work (CSCW) has emerged as a popular and useful area of research, where the main focus has been on the design and implementation of appropriate architectures and tools to support the coordination of the interactions between participants. However, most collaborative applications dealt with so far are of a general purpose type such as brainstorming sessions to assist with group decision making using general shared tools (e.g., calendar, editors, spreadsheets, drawing board) (Stefik et al., 1987; Tou et al., 1994; Rheinhard et al., 1994; Brown et al., 1996; England et al., 1998). These applications also do not require intensive computational cost for generation of large volumes of data or high bandwidth for their transmission over the network. To support collaborative applications which involve dynamic visual data, we need to consider how to distribute not only application data, but also rendering, processing, analysis and display tasks across multiple machines. The majority of existing collaborative work which involves interactive graphics are focused on specific applications, particularly on distributed virtual environments (DVEs) (Calvin et al.,1993; Elliot et al., 1994; Stytz, 1996; Macedonia, 1997) and immersive environments (Poston and Serra, 1994). The main aim of these systems is to provide facilities for designing and handling objects and activities required for virtual environments, hence some of these facilities are not suitable for general purpose graphics applications.

There are also other pertinent issues inherent in such collaborative environments besides those of computational and communication costs, for example, how to model the spatial aspect of interactions in order to devise appropriate methods for supporting flexible and dynamic sharing of data and activities (Hagsand, 1996). However, this chapter only deals with the problems arisen from extensive computational and communication requirements. Our intention is to provide a survey on current approaches for dealing with these