

Better Use of Digital Images in Teaching and Learning

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INTRODUCTION

Digital images are convenient and important media for describing and storing spatial, temporal, spectral, and physical components of information contained in a variety of domains. With the progress of electronics, sensors, computer equipment, and network infrastructure, today's technology enables us to generate, acquire, manipulate, transmit, and store vast (online) image collections. The applications of images, which are expanding over wider and wider areas, have attracted more and more attention in recent years. The use of digital images in teaching and learning is one of the popular application areas.

Currently, distance education offers a new form of teaching and learning. It consists of the conducting of education over a long distance by using modern technology, which enables people to learn what, where, when, and how they want (Zhang, 2001). In reality, distance learning is no longer viewed as a magic legend of advanced technology; it is but an indispensable part of modern life now. The use of digital images induced many possibilities for new distance learning services. For example, the interactive transmission of instructive and demonstrative images to students in remote regions gives the local students the possibility to access remote resources that would not otherwise be available. Thus, how to use digital images efficiently and effectively in teaching and learning, especially for distance teaching and learning, would be very important and should be studied carefully.

Several factors related to the apropos use of digital images, particularly in the context of networked learning environments and course conduction, are discussed. They include the quality of images, visualization of images, tools for image manipulation, as well as fast search and retrieval of images. The underlined concepts, challenges encountered, and so forth will be introduced and dis-

cussed here, which should be beneficial for a better and efficient use of digital images in teaching and learning.

BACKGROUND

It is said that "one picture is worth more than ten thousand words" (Gonzalez & Woods, 2002, p. 1). Human beings observe the majority of the information they receive from the real world from images. In its general sense, the word image could include all entities that can be visualized, such as a still image, video, multidimensional signals, animation, graphics, charts, drawings, text, and so forth. To treat these images, many new theories have been proposed and many new techniques have been exploited. A new discipline called image engineering, including all image techniques, has also been established based on the accumulation of solid research results and the creation of many new applications.

The use of images in teaching and learning has a long history. Since the generalization and compulsory of mass education became popular in 19th century, the visualized form became the most important means of education (Richonnier, 1997). For example, television and films provided detailed accounts of many contemporary events and also were used for classroom presentations. In the 20th century, the invention of electronic computers made the utilization of digitized images in teaching and learning very popular. Nowadays, digital images can either represent digital reproductions of original artwork, such as photographs or paintings, or can be the original digital artwork, such as if an original scene was captured with a digital camera (Süsstrunk, 2002).

Modern theories in educational psychology emphasize that the use of different learning styles would help greatly in knowledge acquisition and

retention. As a support tool for teaching and learning, the utilization of digital images provides the new possibility for teachers to express abstract contents (as the presentation of suitable and realistic pictures is important to stimulate students and to connect teaching and learning practices) and for students to understand difficult concepts (as it provides students with appropriate visual effects and deep impression).

MAIN THRUST

Quality of Images

The quality of images will be influenced by a number of factors, such as the variation of original scenes, the equipment for capturing the incident light, the spatial frequency response of the digitizing system, different processing and analysis techniques, and the resolution of display and print devices. In particular, the resolution that depends on the sampling and quantization plays an important role. The sampling determines the spatial resolution of images and the quantization determines the amplitude resolution of images. Since the storage, transmission, and processing requirements increase very rapidly as a function of both spatial resolution and amplitude resolution, a trade-off must be made between these two resolutions according to the amount of details in an image (Gonzalez & Woods, 2002).

The required image quality for different applications and purposes is distinct (Süsstrunk, 2002; Taylor & Cordes, 2002). For example, when the digital image is only used as a visual reference for some conceptions (like in most teaching and learning cases), the required quality can be relatively low, both in terms of spatial and color or gray resolution content. However, in the case that the digital image represents a replacement of the original in terms of spatial and color- or gray-information content, or the digital image is the central terms of the course (like in many courses concerning image processing and analysis tasks), a higher quality standard would be required.

Considering the teaching and learning practice, the required spatial resolution (for one dimension) for the former usage would be ≤ 250 pixels for thumbnails and $\leq 1,600$ pixels for screen resolution

(Süsstrunk, 2002). As a number of international image coding standards, such as JPEG, JPEG-2000, MPEG-1, MPEG-2, and MPEG-4, have been established and used worldwide, many images and videos available are in compressed forms. Considering the quality, the compression can be made with either lossless or lossy techniques for visual reference purposes, while the compression is often lossless for the replacement usage.

Visualization of Images

Realistic display and compact representation are two meaningful ingredients in the visualization of images. To make a realistic display, techniques such as mosaic (a collective combination technique) and panorama (an overview based on mosaic) are very useful (Tanaka, Arikawa, & Shibasaki, 2002). For example, QuickTime VR (2004) has been widely used in publishing photo-based pseudo 3-D spaces with panoramic representation.

While mosaic techniques can provide a compact representation of a group of still images, using a moving edge-overlaid frame (MEOF) can provide a compact representation of a clip of video (Yu & Zhang, 2002). Such a technique is inspired from the eye's temporal integration behavior, and realized by integrating the edges (as the edges could characterize the general shape and position information of the moving objects) of moving objects along the time axis to create a motion effect. In fact, MEOF can summarize both the local-object-motion and global-camera-motion information of the video clip.

One illustrating example is given in Figure 1 (Zhang & Yu, 2002), where the edges of the running person extracted from the previous frames are overlapped on the last frame of this sequence. Without the overlapping of edges, one can only see the current position of a running person. With the overlapping of edges, it is easy to perceive that the person stands in the beginning and then starts to run in the direction of left to right. In this way, more information about moving objects, such as the trajectory of a moving object during a period, could be revealed. Such a representation will even enable a faster perception for the user than viewing the actual video.

Video is composed of a sequence of frames. Though each frame in a video can be considered as

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