Teaching and Learning Image Courses with Visual Forms

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INTRODUCTION

It is said that "one picture is worth more than ten thousand words" (Gonzalez & Woods, 2002). Human beings observe the majority of the information they receive from the real world from images. 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, the applications of images, which are expanding over wider and wider areas, have attracted more and more attention in recent years. The use of images in teaching and learning is one of the popular application areas.

In its general sense, the word "image" could include all entities that can be visualized, such as a still image, video, multi-dimensional signals, animation, graphics, charts, drawings, text, and so forth. All of them are in visual forms, and can be called general images. 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 established based on the accumulation of solid research results and the creation of many new applications.

To provide the basic principles for treating images, a number of image courses, such image processing, image analysis, and image understanding are conducted in almost every engineering school of university. In all these courses, the use of images induced many possibilities, and how to use images efficiently and effectively in teaching and learning would be very important and should be studied carefully.

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 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).

Several visual forms related to the apropos use of images in teaching and learning image courses are discussed. They include animation, condensing video content into frame, online interaction with images, as well as object-based image retrieval. The underlying concepts, challenges encountered, and so forth, will be introduced and discussed here, which should be beneficial for a better and efficient use of images (in its general senses) in teaching and learning.

BACKGROUND

Visual form is a general term. A basic form of images is 2-D still gray level images, which can be represented by $f(x, y)$. A general image representation function is a vector function $\boldsymbol{f}(x, y, z, t, \lambda)$ with five variables, where $\boldsymbol{f}$ stands for the properties of world represented by image, x, y, z are space variables, t is a time variable, and λ is a frequency variable (or wavelength). Some typical examples of extension from $f(x, y)$ to $\boldsymbol{f}(x, y, z, t, \lambda)$ are:

1. Consider that $f(x,y)$ is an image formed by getting the irradiance from object surfaces. If cut, the object along the capture direction into a number of sections and capture the image for each section, the integrated 3-D spatial information of object (including its inside) can be obtained. In other words, a 3-D image $f(x, y, z)$ is obtained. Imaging modalities, such as CT, MRI are typical examples.
2. Consider that $f(x, y)$ is a still image captured at a certain moment. If captured multiple images consecutively along the time axis, the integrated 3-D temporal information (including dynamic information) of object can be obtained. Video

and other sequence images are kinds of such 3-D image $f(x, y, t)$.

3. Consider that $f(x, y)$ is an image captured the irradiance of only one wavelength. If multiple wavelengths are captured, images with different properties (corresponding to reflection and absorption of different wavelength λ) can be obtained. These images are either 3-D images $f(x, y, \lambda)$ or 4-D images $f(x, y, t, \lambda)$. Multi-spectrum images are some examples, in which each image corresponds to different wavelengths, while all of them correspond to the same space and time.
4. Consider that $f(x, y)$ is an image with only one property in the space location. In fact, the scene at one space location can have multiple properties. Or in other words, an image can have several values at point (x, y) and can be represented by a vector $\boldsymbol{f}$. For example, a color image is an image having RGB three values at a pixel, $\boldsymbol{f}(x, y) = [f_r(x, y), f_g(x, y), f_b(x, y)]$.
5. Consider that $f(x, y)$ is an image obtained when projecting 3-D scenes. In this process, the depth or distance information would be lost. If multiple images obtained from different view points but for the same scene can be combined, an image with all information in scene (including depth information) can be obtained. The image with property as depth is called depth map: $z = f(x, y)$. From depth map, 3-D image $f(x, y, z)$ can be derived.

MAIN FOCUS: COURSE DESIGN WITH VISUAL FORMS

Course design is critical for teaching and learning (Zhang, 2005b). Some useful visual forms are discussed in the context of teaching and learning, with several examples, in the following.

Animation

Animation can provide a succinct representation of dynamic process. One example is as follows. Human vision system exhibits several phenomena in which perceived brightness is not a simple function of intensity. One of them is called simultaneous contrast. This phenomenon is often illustrated by showing several images with different foreground and background regions. Sequences of typical images are shown in Figure 1. In these images, all the center circles looked as foreground have the same intensity, while the background squares have different intensity values. The contrasts between circle and square regions for each image are different, so the center circle regions are looked with different brightness.

If the animation technique is used, by keeping the intensity of circles to be constant while increasing the intensity of squares from darkest to lightest, the observer will get directly the filling that the intensity of circles change from lightest to darkest and the circle is moving away. People considered that it is hard to put the feelings into words, while animation can help to produce and express filling.

Figure 2. Animated chain coding process

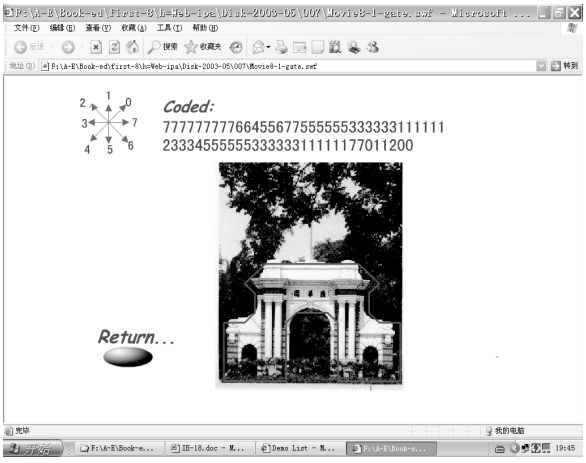

Figure 1. Phenomenon of simultaneous contrast