Research Statement
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Over the past 7 years as a researcher, I examined non-photorealistic rendering [4, 5, 7, 9, 10, 15], as well as human perception in immersive environments [1, 2, 5, 12, 16, 17] and computer-generated and modified imagery [3, 6, 8, 14]. My research involves the interdisciplinary synthesis of computer graphics, perceptual psychology, art theory, and computational vision. My primary research goal endeavors to better understand spatial information available in computer generated imagery, determine what cues are actually used, and then create improved rendering algorithms.

Current Research

The creation and modification of imagery must be done with care, otherwise the content and context of the information may be misconstrued or lost. In addition to data-reduction and sampling errors introduced by some image manipulations, modification of imagery may not preserve the semantic content or important large scale features of an image. For example, consider converting an image from color to grayscale, shown in Figure 1. Visible boundaries between isoluminant colors are lost in the default grayscale conversion. A solution to this problem should incorporate the perceived boundaries in the color image into the grayscale image.

Vision scientists hypothesize that the human visual system does not perceive absolute values, and instead percepts such as chrominance and luminance perception are based upon relative assessments, in part due to the center-surround organization of cells in the early stages of visual processing [13]. Based upon the idea that difference-preserving mappings are important, my research explores mappings that preserve the semantic information contained in imagery even if image values, such as color and intensity, are not strictly preserved. This leads to several interesting research questions: instead of manipulating digital images as independent pixel values, can images be manipulated in a way that preserves perceived changes, and what does this type of image manipulation do to the semantic information in the image?

Typically computer graphics algorithms have focused on mapping the color and intensity at a position in a scene to a pixel value on a display device. However, there are many visible parameters sensed by the human visual system including color, intensity, position, orientation, texture, shape, edges, and motion. In order to take a more general view and consider a wider set of all potential mappings, one can think of the mapping from a scene to an image in matrix form. The main diagonal of this matrix represents the photorealistic mappings of scenes to displays. My long-term research plan examines methods for creating effective imagery by exploring mappings off the main diagonal.

I believe that some off-diagonal mappings not yet widely recognized include children's coloring books that map edges in a scene to rendered lines or strokes in an image. Additionally, such mappings are not foreign to computer graphics and visualization. For example, the visualization of abstract concepts such as flow fields that can be more easily understood by mapping glyphs or texture elements to orientation [11].

The strength of examining these off diagonal mapping lies in creating imagery that preserves the magnitude of the difference between regions. I believe changed-based mappings will yield images with a larger number of visual cues than mappings that do not. More importantly, I believe that information in a scene can be conveyed by mapping scene region differences to changes in any renderable visual parameter.

In my current research, I create new mappings for:

- Color to Gray conversion: creating better color to grayscale conversion algorithms that preserve changes present in the color channels.

(a) Original Color Image (b) Default Grayscale Conversion (c) New Color2Grey Conversion

Figure 1: *New color-to-grayscale conversion.*
a) Source color image. b) Converting the source image to grayscale by discarding all but the CIE Y channel results in the loss of important image features visible in the color image, such as the sun and its reflection in the water. c) Preliminary results of our algorithm incorporate changes available in the chrominance channels into a new luminance-only image. Image of "Impressionist Sunrise" by Claude Monet; Image courtesy of Artcyclopedia.com

- Multi-spectral Image Archive: generate static and dynamic images that incorporate multi-spectral data, revealing detailed spectral data inside and outside the visible spectrum.

There are many other mappings from perceived visible parameters in a scene to visible parameters in a display to explore. My research involves collaboration with cognitive and perceptual psychologists, and may be useful for visualizing data from fields such as homeland security, bioengineering and nanotechnology, in order to create image processing and rendering algorithms that communicate more effectively than current images techniques such as false coloring. My research concentrates on the creation of images specifically targeted for the human visual system, in contrast to previous research efforts that have focused solely on the mapping of images to monitors, projectors, or paper.

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