Vidya Setlur: Research Description
Optimizing Computer Imagery for Communication

Figure 1: *My work introduces techniques for automatically retargeting images and animation. This involves adapting them for display at different sizes and aspect ratios while preserving the recognizability of important image features. Left: A source image containing three areas of importance, the two boys, and the ball. Center: The source image retargeted to fit a PDA display. Right: The source image retargeted to fit a cell phone display.*

Abstract

Computers are becoming faster, smaller and more interconnected, creating a shift in their primary function from computation to communication. This trend is exemplified by phenomena such as cellular phones with cameras, personal digital assistants with video, information displays in automobiles, and computer screens in elevators and refrigerators. As communication devices and viewing situations become more plentiful, we need imagery that facilitates visual communication across a wide range of display devices. In addition, producing effective and expressive visual content currently requires considerable artistic skill and can consume days. The goal of my research is to develop new techniques and user interfaces that enhance visual communication, while making it fast and easy to generate compelling content. My research combines concepts and methods from visual art, perceptual psychology, information processing, and cognitive science to facilitate users in creating, understanding and interpreting computer imagery.

I am currently conducting research in three areas:

- **Image Retargeting**, to provide effective small images by preserving the recognizability of important image features during downsizing.

- **Semanticons**, an information visualization method for automatically generating semantically enhanced file icons in desktop applications.
- **Animation Retargeting**, to enable animation created for the World Wide Web to accommodate the aspect ratios of hand-held display devices.

Image Retargeting

The motivation for this work is the need for tools that allow us to author imagery once, and then automatically retarget that imagery for a variety of display devices as needed. The problem is to retarget an image to a new size and/or aspect ratio in a manner that preserves the recognizability of the important features of the image. To do this, the features of the image must be identified, their importance determined, and then the image needs to be re-arranged such that the important features are well-represented.

(a) Original Image (b) Retargeted Image

Figure 2: *My image retargeting method moves important regions close together while maintaining the size, aspect ratio, and spatial relationships of important regions of the image.*

(a) Crop (b) Scale

Figure 3: *a) Cropping can omit important objects. b) Scaling can introduce distortion.*

Given a source image and a specification for the size of the output image, the retargeting algorithm proceeds

as follows, and is illustrated in Figure 4. First, separate the image into regions by segmenting it. This process involves image segmentation and adjacent region combination based on the spatial distributions of color and intensity. In order to identify important regions, generate an importance map of the source image based on a computational low level vision model and a face detection method. If the specified size contains all the important regions, the source image can be cropped. Otherwise, the important regions are removed from the image, and the resulting "holes" in the background filled. The updated background is then resized to fit the input specification. Regions of importance are then "pasted" back onto the updated background based on importance and relative topology within the scene. If all the important regions cannot fit within the new image, they are resized in inverse proportion to their importance. Prototypical results, shown in Figure 1 and Figure 2b, demonstrate that this technique tends to minimize the loss of detail and distortion that traditional techniques introduce (Figure 3). In addition, the method moves noticeable regions closer together while retaining key feature relationships as demonstrated in Figure 2.

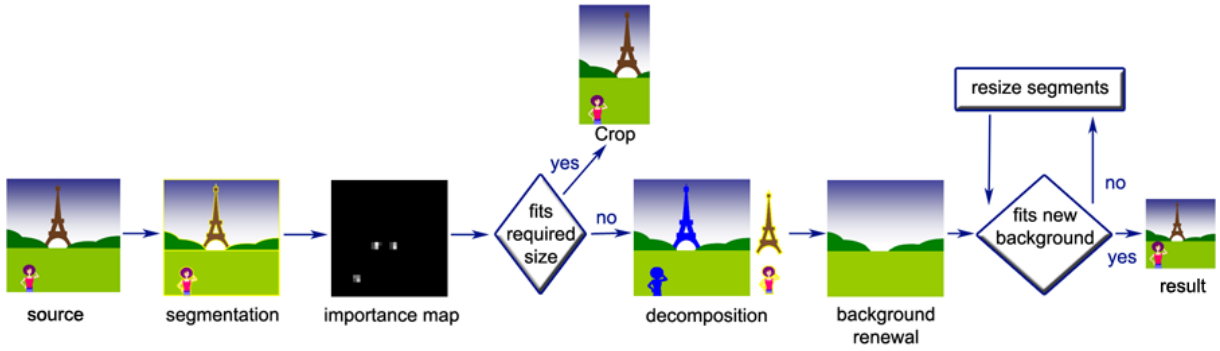

Figure 4: *Flowchart of image retargeting process. Both the Eiffel Tower and the person are important.*

Figure 5: *Semanticons are an information visualization method for enhanced file icons.*

Semanticons: Semantic-Based File Icons

The goal of this work is to automatically generate icons that better reveal the files' contents. Since the introduction of the desktop metaphor, the number of files that users manage has increased dramatically. File browsing methods, however, have only improved marginally. Existing file managers such as Windows Explorer help users locate files by providing a visual representation, such as thumbnails for images, while others are assigned icons based on the applications that are used to open the files. Thumbnails, while seemingly linked to the files' contents, are often difficult to perceive and interpret due to small size. Associating icons solely with applications leads to rows of identical icons that are not perceptually distinct.

Semanticons can enhance the representation of files in a Graphical User Interface (GUI) by offering symbols that are semantically and visually distinguishable, as shown in Figure 5.

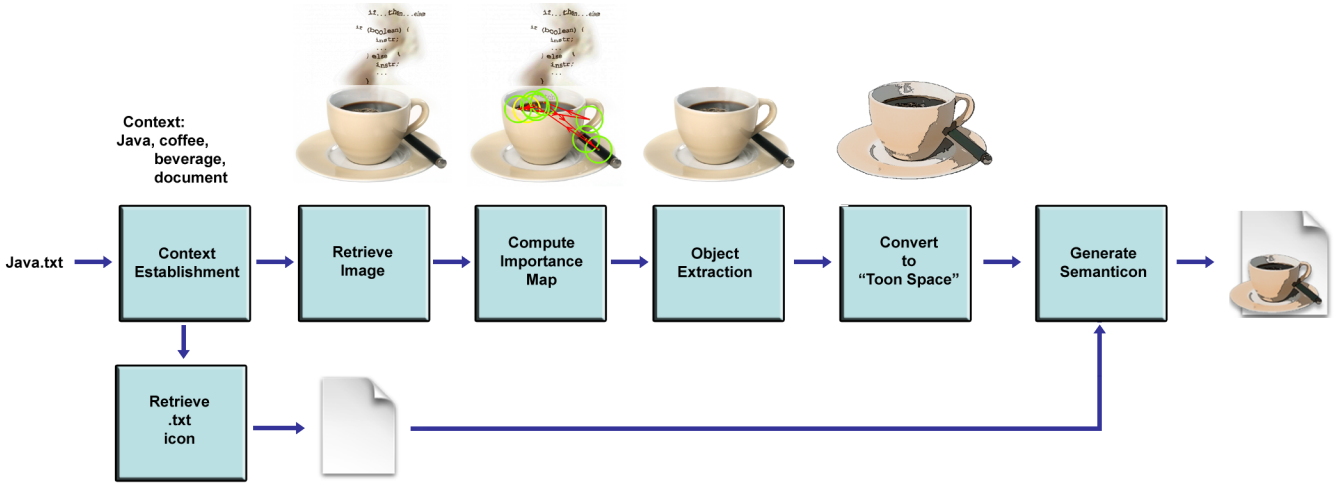

Figure 6: *A flowchart of the semanticon generation process.*

The meaning of a file is estimated by parsing its name, location, and content to form a 'context'. The context is then used to query for images in a stock photography database, indexed by keywords. The semantically meaningful images are then simplified by segmenting them and computing an importance value for each segmented region. Unimportant regions are removed from the image. To increase the effectiveness of the semanticons, and maintain the abstract look-and-feel of icons, artistic computer techniques for edge enhancement and cartoon coloring are applied to emphasize important features. The images are then composed with icons from contemporary GUIs to generate the final semanticon. Figure 6 illustrates the semanticon generation process. I have conducted two psychophysical studies using semanticons as stimuli. The studies demonstrate that semanticons, when compared to traditional GUI icons, decrease the time

necessary to locate a file in a visual search task, and enhance performance in a memory task.

Animation Retargeting

(a) Original Animation (b) Scaled Animation (c) Retargeted Animation

Figure 7: *Preserving the spatial detail in important objects from a source animation to a smaller sized animation.*

Advances in mobile devices and wireless telecommunication provide users with ubiquitous access to online information and services. However, user access and interaction are still quite restricted with regard to the display of imagery such as animations, diagrams, maps, and charts. There exists a growing need for the effective adaptation of imagery for small size displays. This work presents an algorithm for retargeting vector based animations while maintaining the recognizability of object interaction.

Effective display consists of understanding the communication goal of some form of imagery and then fitting that imagery to the display device in a manner that aids this goal. In most animation, the story is communicated to the viewer via the interaction of a few **key objects**. Remaining objects in the scene provide a context for this interaction, and are referred to as **contextual objects**. In order to achieve the communication goal of an animation on a mobile device, key object interactions must be displayed at both sufficient size and spatial detail for easy recognition. The contextual objects in the animation are less important. The premise of our method is that when the key objects are known, their features can be exaggerated in order to render their interaction more obvious.

Objects in vector graphics images and animation are typically uniformly scaled regardless of their importance. Therefore, we introduce a perceptually motivated algorithm that exploits the semantics of vector graphics data to guide the retargeting process. In addition, the algorithm redistributes spatial detail among the objects in the scaled animation based on importance. For example, in Figure 7b, detail in the outlines of the windmill's windows is lost when the animation is scaled down. On the other hand, the retargeting method retains the key features necessary to distinguish the window outlines as shown in Figure 7c.

Conclusion

The retargeting methods presented in this work open the door for a number of potential applications of context driven graphics and information adaptation. Ubiquitous devices, particularly mobile phones present challenges for the delivery of wireless content. The majority of content delivered to phones is typically text-based and restricted to simple graphics or downloadable ring-tones, wallpaper and games. However, new 3G phones and Web browser technology, are becoming more promising for richer content delivery (e.g., video) and rendering closer to that of a desktop browser display. The main challenge is deciding what is needed for the target audience and the retargeting work can be applied to determine optimal approaches in the creation and layout of mobile content. My work can not only be applied for display critical purposes, but also to general, commonly used applications that can help the user to quickly locate information or make a given task more efficient. To summarize, my work provides a catalyst for the creation of functionally effective computer graphics environments for people: wherever they are, whomever they interact with and whatever they are doing.

References

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[3] Semanticons: Visual Metaphors for Files. Vidya Setlur, Conrad Albrecht-Buehler, Amy Gooch, and Bruce Gooch. Eurographics 2005.

About the Author

Vidya Setlur is a graphics and UI researcher at the Computer Graphics and Vision Group, Nokia Research Center. She graduated from Northwestern University in 2005 with a Ph.D. in computer graphics. She enjoys applied computer graphics research with an emphasis on practicality and usefulness to better facilitate tasks performed with a computational device. Her main interests concern interdisciplinary work that encompass a variety of areas including art, natural language processing, mathematics, UI concepts and graphics design.