The RIT Visual Perception Laboratory

Members of RIT's Visual Perception Laboratory (VPL), housed in the Chester F. Carlson Center for Imaging Science, make use of state-of-the-art instrumentation monitor and analyze observers' gaze patterns as they perform a wide range of tasks. Head-mounted, video-based eyetrackers manufactured by Applied Science Laboratories and ISCAN are used to track participants' gaze patterns in the laboratory. Coupled with a magnetic-field head tracking system, it is possible to monitor observers' point of regard in image coordinates without the need to restrain the head. The Visual Perception Lab is also equipped with a 'remote' eye-imaging camera that allows gaze patterns to be monitored without head-mounted instrumentation. The VPL is equipped with a range of display devices including CRT, Apple 22" Cinema Display, and a Pioneer 503CMX 50" plasma display.

In addition to the commercially available eyetracking systems, RIT's Visual Perception Laboratory continues to innovate in the design, fabrication, and application of novel eyetracking systems. The 3rd-Generation RIT Wearable Eyetracker is a unique device that is capable of monitoring observers' gaze while engaged in active behaviors ranging from watching a classroom lecture to playing racquetball.

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www.cis.rit.edu/vpl
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Laboratory-based eyetrackers:

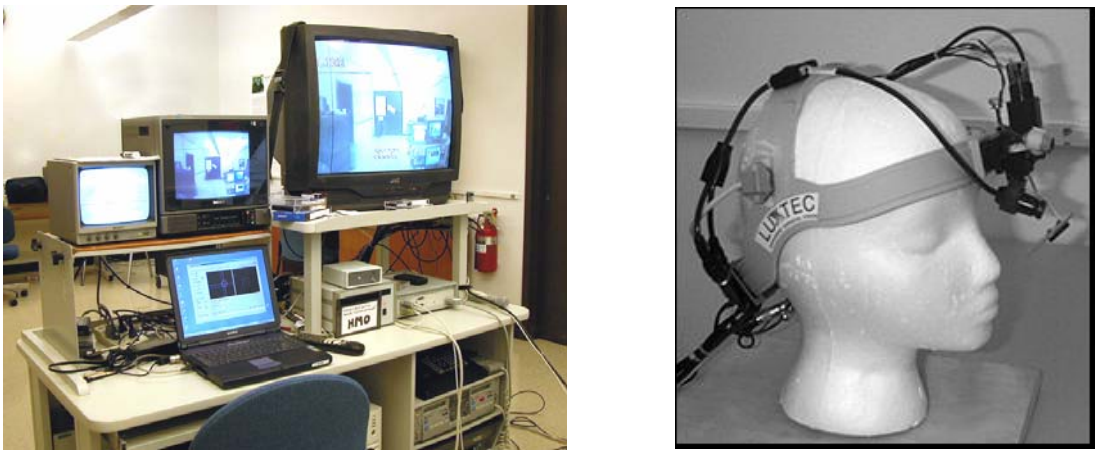

Figure 1 ASL Series 500 eyetracker system (left) and Model 501 headband-mounted optics (right)

The Applied Science Laboratories (ASL) Series 500 infrared, video-based eyetracker shown in Figure 1 is used with the Model 501 headband-mounted optics also seen in the Figure. The ASL provides a 60 – 240 Hz data stream indicating the observer's point of regard in eye-in-head coordinates, and a 60 Hz video record of the viewer's point-of-regard superimposed over the field of view (see Figure 2).

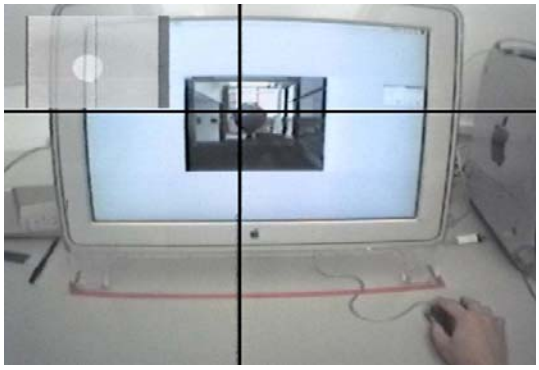

Figure 2

Eye/Head Gaze Integration:

The data stream from the eyetracker provides eye position in a head-based reference frame. To determine the point of gaze in world coordinates, the position and orientation of the head are also tracked. Using the Polhemus Fastrak magnetic-field head tracking (MHT) system shown in Figure 3, it is possible to monitor an observer's effective gaze point in world coordinates. The eye-in-head orientation, and head position and orientation are integrated to provide the final gaze vector. The point of regard in image coordinates can be determined when the position and orientation of the display is known with respect to the MHT transmitter.

Figure 3 Polhemus Fastrak magnetic-field head tracker

ASL Series 504 Remote Eyetracker

The Visual Perception Lab is also equipped with 'remote' eye-imaging camera that allows eye movements to be monitored without the need for head-mounted hardware. The ASL Model 504 60 Hz remote optics system shown in Figure 4 illuminates and images the eye from below the image display. The observer's head must remain relatively still, but the remote optics system eliminates the need to integrate eye and head position, and can be calibrated to provide gaze position in image coordinates. Both systems provide an accuracy of approximately ± ½°.

Figure 4 Model 504 "remote optics"

Image Displays:

Image display devices available in the Visual Perception Laboratory include an Apple Cinema LCD Display, a Pioneer 503CMX 50" plasma display, and a Sony G420 high-performance CRT.

Figure 5

RIT Wearable Eyetrackers

In addition to the commercially available eyetracking systems, RIT's Visual Perception Laboratory continues to innovate in the design, fabrication, and application of novel eyetracking systems. The 2nd-generation RIT Wearable Eyetracker, shown in Figure 6 and Figure 7, provides a valuable new tool for investigating visual perception in a range of natural tasks outside the laboratory.

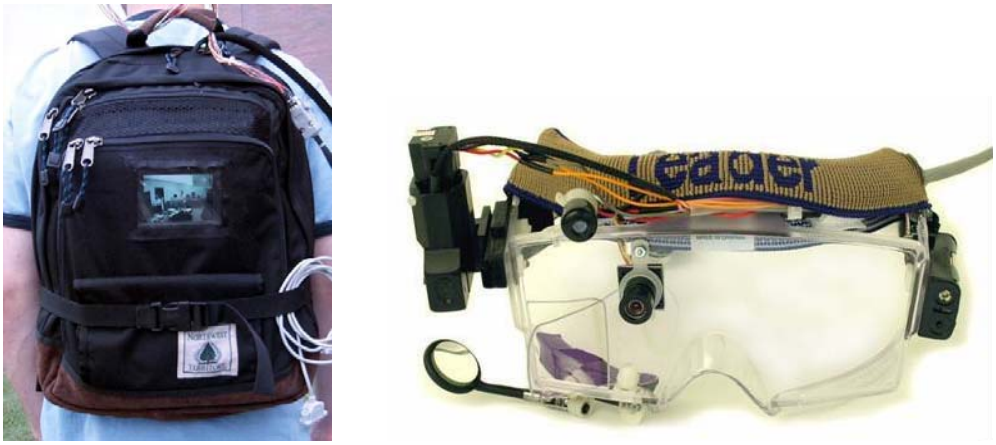

Figure 6

Figure 7

The wearable system can be used in the laboratory as well – it has proven to be a valuable tool in human factors research. The 3rd-generation RIT Tracker, shown in Figure 8, is still smaller and lighter and has opened up an even broader range of natural tasks to investigation, from driving to sports such as squash (see Figure 9).

Figure 8

Figure 9

The 3rd-generation tracker is designed for off-line analysis. Raw video of the eye and scene are captured using the backpack or portable systems shown in Figure 8, while calibration and analysis are carried out later in the laboratory, making data collection 'in the field' more efficient.

Figure 10 Off-line analysis

Visualization:

A number of visualization tools are available for representing observers' gaze patterns. In addition to the video record showing gaze pattern over time, the eye movement patterns can be indicated in image overlays, as shown in Figure 11, or reported in image coordinates, as in Figure 12.

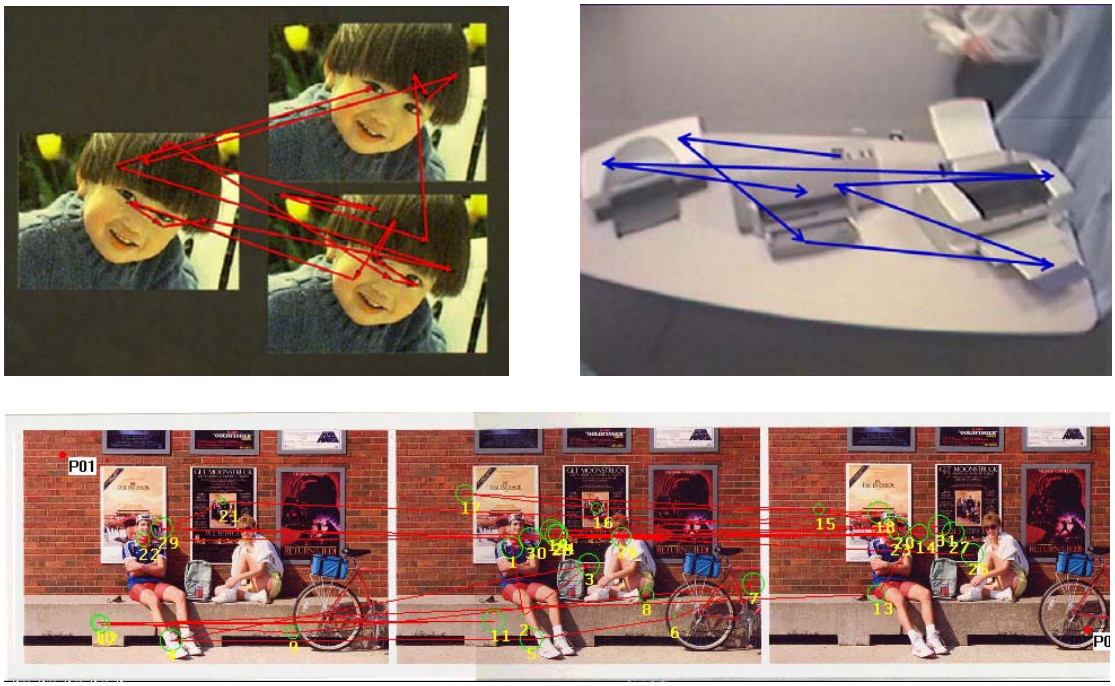

Figure 11

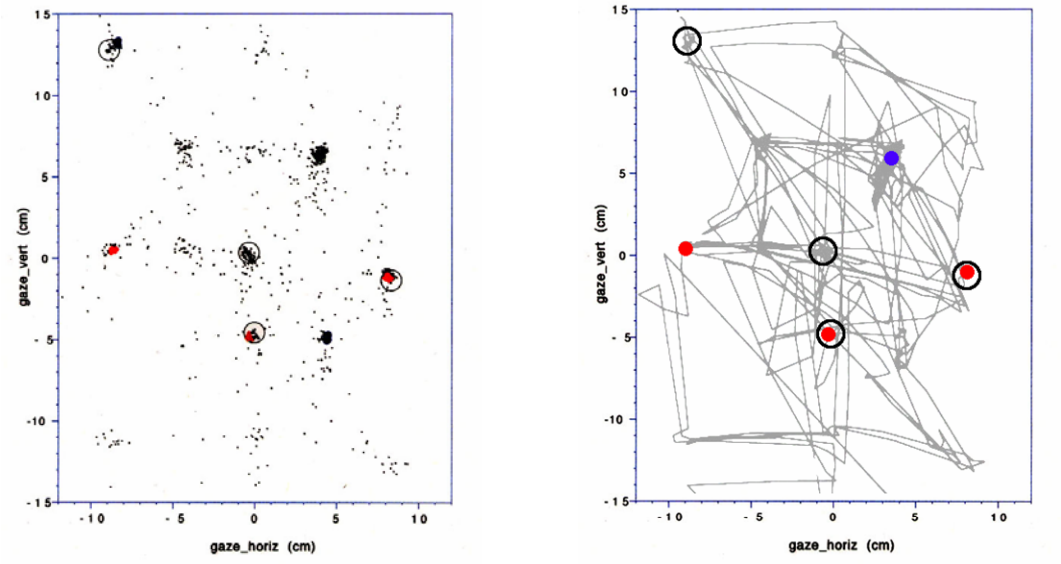

Figure 12

The gaze patterns can also be represented by indicating the concentration of visual attention in two or three dimensions, as shown in Figure 13.

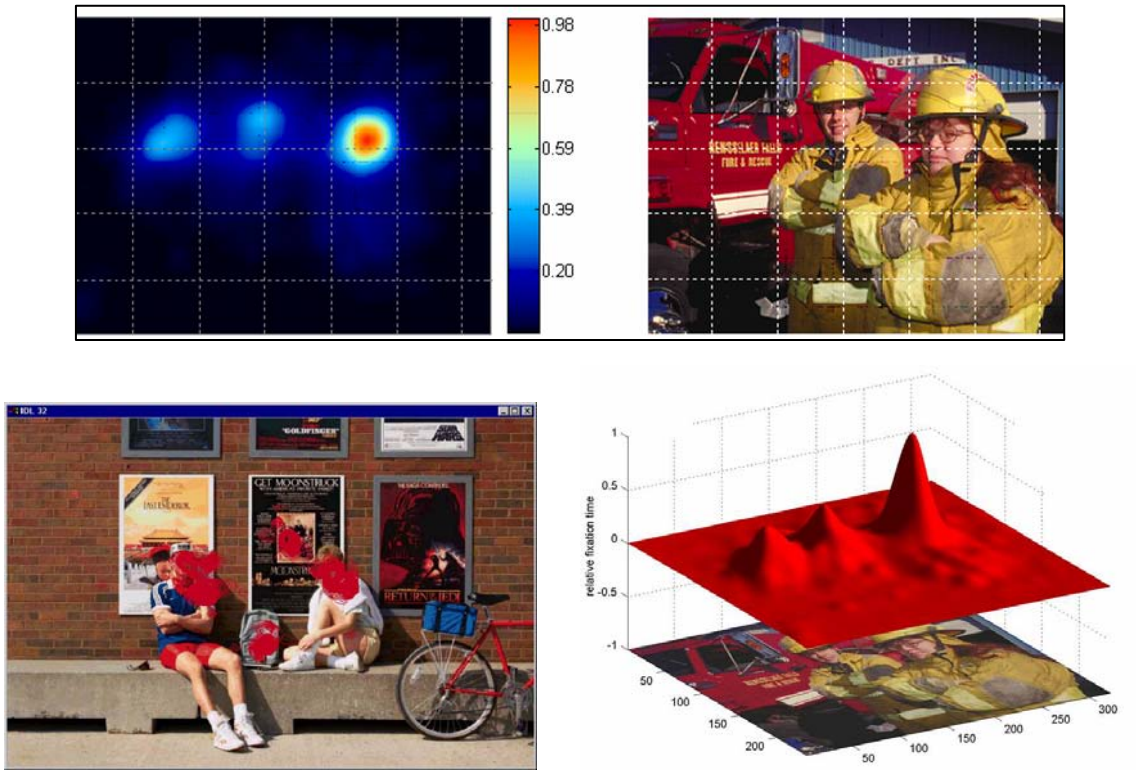

Figure 13

It is often desirable to compare different observers' gaze behavior as they perform the same task. Figure 14 illustrates the first four fixations of ten observers completing a visual-search task.

first fixation second fixation

third fixation fourth fixation

Figure 14

Members of the Visual Perception Laboratory at the Rochester Institute of Technology make use of these state-of-the-art instrumentation and visualization methods to bring a better understanding of observer behavior in a wide range of visual perceptual tasks.

More information is available at www.cis.rit.edu/vpl/ and www.cis.rit.edu/pelz/