Dynamic Control Of Magnified Image For Low Vision Observers

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Purpose: Magnification is an effective aid for people with conditions causing resolution loss. However, it inherently restricts the field of view. We have developed a system of magnifying television images while addressing the field restriction in two ways.
Methods: The system requires a point in each video frame that is to be centered on the screen when the image is magnified. This selection should maintain the most relevant details in the scene. The coordinates of this “center of interest” point can potentially be included with each frame. The eye movement patterns of normal-vision observers were used to determine the centers of interest within scenes. Six ten-minute video segments were selected from a broad range of scenes. To the extent possible, centers of interest were defined in terms of objects. For example, if a view fixated on a person’s nose and then moved fixation to an ear, the object of fixation in both cases was defined as the person’s head. In typical use, the visually impaired person uses a remote control to adjust the magnification (“zoom”) and can also override the pre-set center of interest (“roam”). To maintain wide field context, an edge-enhanced outline of the full scene can be superimposed on the magnified image.
Results: A system implementing the magnification and shifting was built and integrated to use the preset center coordinates. A real-time outline derivation system that superimposes an outline of the full frame on the magnified image was developed. Eye movement patterns were analyzed off line. A comparison across groups allowed us to compare differences in areas of interest or eye movement patterns based on age or gender. The location of the center of each object was translated to the center of interest attached to the frame. Modified videos were shown to low vision patients with and without the full field outline. Magnification preferences, override frequency, and satisfaction were recorded. Patients were also interviewed regarding the impact of information in the scene that might have been missed due to the magnification.
Conclusion: A demonstration system will be available for use during the poster session.

Abstract

Purpose: Magnification is an effective aid for people with low vision conditions causing loss of resolution. However, it inherently restricts the field of view. We have developed a system of magnifying television images while addressing the field restriction in two ways.

Methods:
1. Magnified image is displayed centered on "Point of Interest" or "Point of Regard" (POR) of the frame. This POR is determined on a frame-by-frame basis from the response of normally sighted viewers.

2. To maintain context, a real-time outline derivation system that superimposes an outline of the full frame on the magnified image was developed. This POP (Picture Over Picture) technique provides spatial multiplexing of the full view.

Determination of POR
Eye recording data was used to identify, across normally sighted viewers, fixations that overlap in time and position. These overlaps define the center of interest in the scenes (POR).

Conclusion: A demonstration of a prototype system is available for use during this session

Background

- Visually Impaired people benefit from magnification
- Electronic zoom can magnify TV
- Magnification reduces field of view
  - Solutions
    - Center magnification at point of interest
    - Provide spatial multiplexing of full view
      - Picture Over Picture (POP)

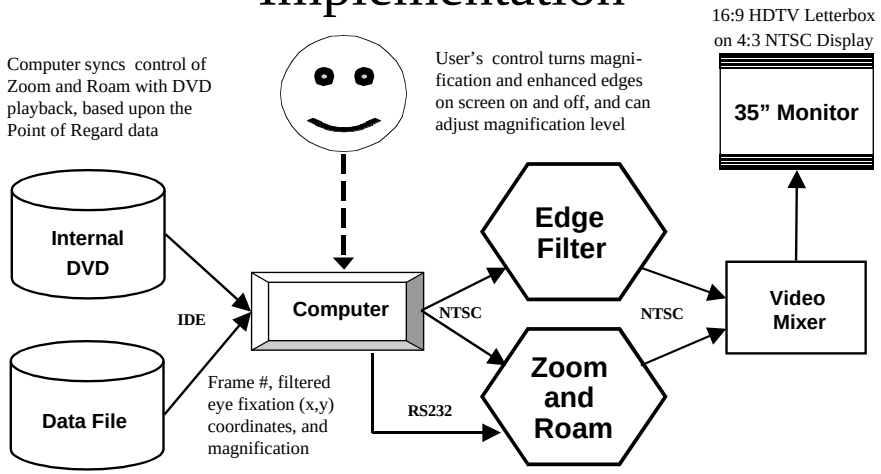
Picture Over Picture (POP)

Original Image

POP Magnified Image

- Point of Interest is provided with video frame
- Magnification is centered at Point of Interest (POR)
  - Maximum magnification limit is also provided
- Edge enhanced image (original size) superimposed on magnified image (POP)
  - Edge-detection of original size image in real time
- User controls level of magnification and on/off of edge-detected image

Implementation

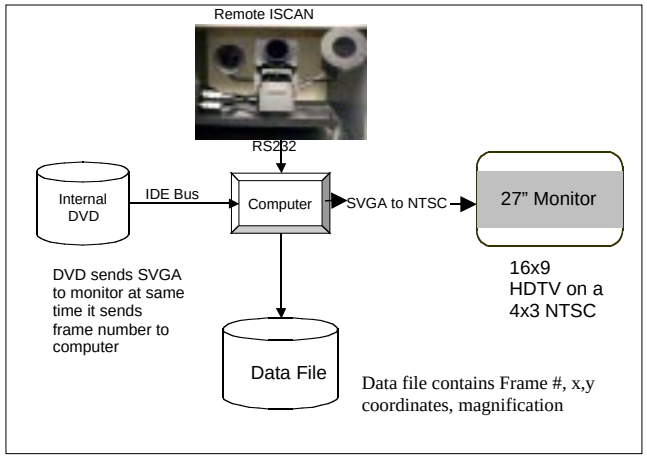


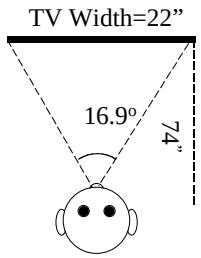
Point of Interest of Observers

- Computer “plays” DVD while reading eye position data from ISCAN device
- ISCAN Specifications
  - Pupil/Corneal Reflection Video System
  - Sampling Rate 60Hz
  - Accuracy of 0.5º over ± 20 º range
- MS DirectX 8.1Technology (Microsoft)
  - The MSWebDVD object provides the Visual Basic 6 interface used to control the DVD

- Calibration
  - 5 point ISCAN calibration
  - Calibration rechecked and redone (if necessary) between video segments
- Synchronization with DVD
  - MSWebDVD only provides an actual frame count at the beginning of an 0.4 to 1 second block of video data on a DVD. We use a VB timer event (interrupt every 33ms) to interpolate to frame-level precision.

System Diagram of Recording Phase





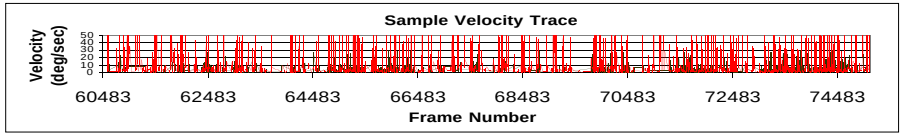
Categories of Videos and Observer Groups

6 Segments Drawn from Different Categories of Video

Category	Title	Time (hh:mm:ss)
Talk Show	Quiz Show	00:06:40
Romance	Shakespeare in Love	00:07:06
Sports	Any Given Sunday	00:04:12
Documentary	Blue Planet	00:08:14
News	Network	00:04:02
Comedy	Big	00:06:29
Total		**00:37:29**

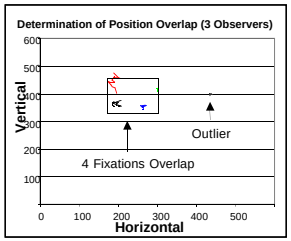
Group (Gender-Age)	N	hh:mm:ss (Useful data)
Male < 40	7	04:09:23
Male > 45	3	01:49:56
Female < 40	5	03:21:33
Female >45	4	02:26:42

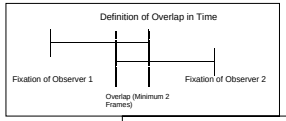
POR Across Observers



- Artifact Removal
  - Zero data (loss of tracking, blinks) are removed
  - Saccades - Data rejected if velocity exceeds 30º per second
  - Data rejected if pupil diameter too large or too small

- Remaining data are characterized as Fixations or Smooth Pursuits
- Data is considered a Pursuit unless either
  - Horizontal range and Vertical range is less than 50 pixels (Visual angle 1.6 º)
  - Correlation coefficient between X and Y values is less than 0.5





After outliers are removed, the average <x,y> position is found. A fixation sequence is defined to be an overlap if it is within the bounding box centered at <x,y> of side 128 pixels (Visual angle 4.2 º)

SEE DEMONSTRATION OF DVD PLAYBACK OF EYE MOVEMENTS

Hardware Systems

Subject Viewing Video

DZ1-Zoom And Roam

Edge Filter Process

$Y = c(E-\hat{E})$

Y = output image

c = contrast

E = input image

$\hat{E}$ = local average luminance

Preliminary Recording Phase Results

Group	% Zero Frames	% Pupil Rejects	%Saccade Rejects	%Other Artifact Reiects*	% Accepted	# Fixations	#Pursuits
M<40	9.2%	8.5%	7.6%	26.3%	48.3%	16032	1404
F<40	10.8%	24.8%	6.4%	25.6%	32.3%	9644	752
F>45	21.4%	17.6%	5.6%	23.8%	31.5%	6777	471
M>45	11.9%	27.8%	5.2%	25.6%	29.6%	4914	465

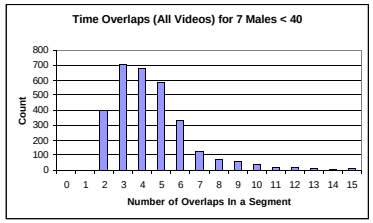
Other Artifacts include

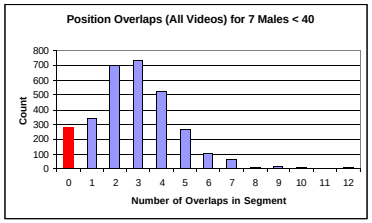
-Removal of first and last frames of every "accepted" sequence

-Duplicate or non-monotonic frame numbers (due to interactions between the timing of the DVD and ISCAN)

-Rejection of sequences with fewer than 4 frames

The number of segments that have fixations that overlap in time and of the number that have overlaps in time and position





System Demonstrations

- Eye positions superimposed on video
- POR Controlled Zoom System
  - For sections of video where no position overlap exists, center of magnification is kept at prior center
- Real-time edge enhanced image
- Data Analysis System

Future Work

- Analysis of POR variation within and across groups
- Better determination of POR to use with the display system (smoothed, threshold POR changes, handle pursuits)
- Conduct "satisfaction and use" study with low vision population
- Integrate POR into DVD and other video formats (broadcast POR with frame

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