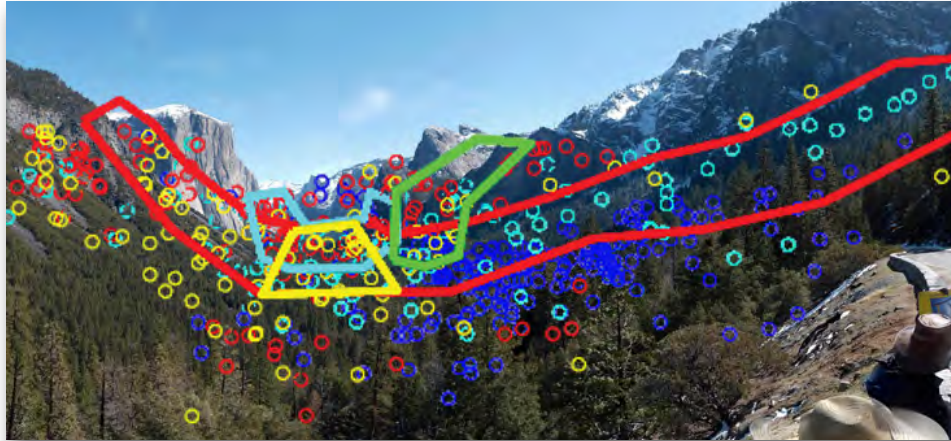


Semantic Analysis of Mobile Eyetracking Data

Jeff B. Pelz

Rochester Institute of Technology
Rochester, NY, USA



1st International Workshop on Pervasive Eye Tracking and Mobile Eye-Based Interaction



UBICOMP 2011
Beijing, China

Ubiquitous Computing
September 17-21, 2011

Many problems suggest themselves to the psychologist whose solution would be greatly furthered by an accurate method of recording the movements of the eye.

A METHOD OF RECORDING EYE-MOVEMENTS.

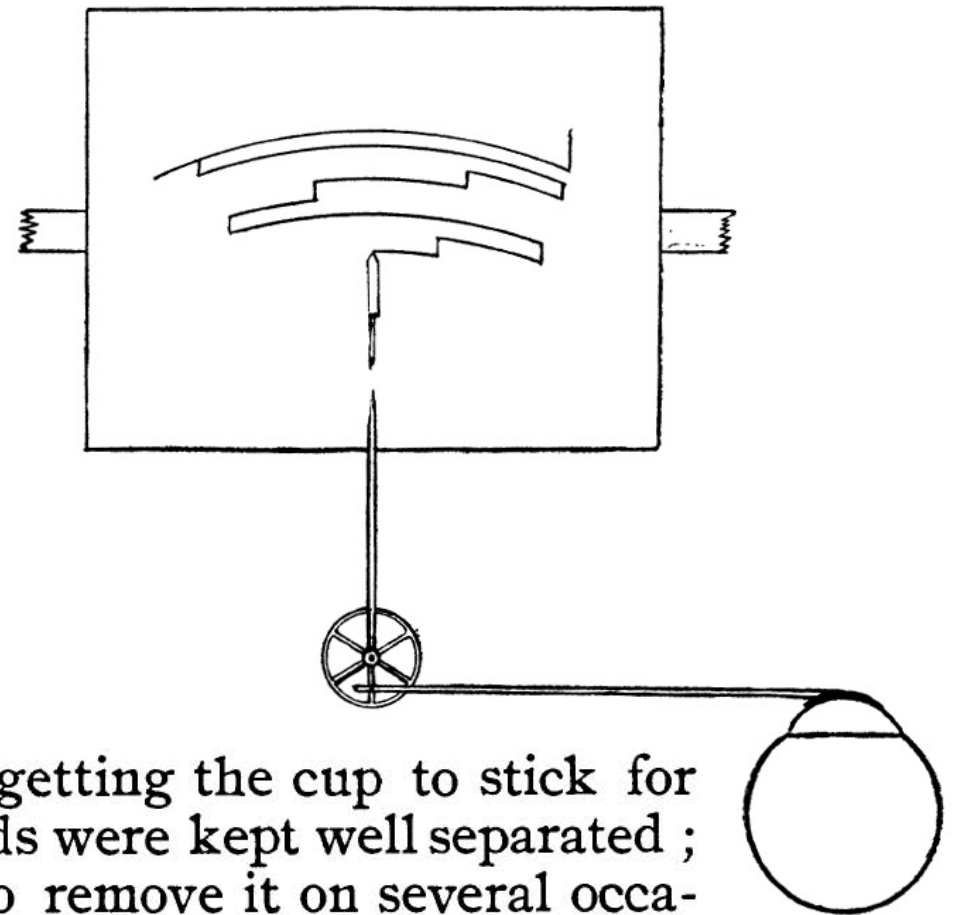
By E. B. DELABARRE, Professor of Psychology, Brown University.

Many problems suggest themselves to the psychologist whose solution would be greatly furthered by an accurate method of recording the movements of the eye.

I am indebted to Dr. Lough, my assistant last year in the laboratory at Harvard, for the suggestion that plaster-of-Paris will attach itself firmly and immovably to any moist surface. Acting on this suggestion, I made a few plaster casts over the cornea of an artificial eye. I thus produced a smooth concave surface that would fit fairly well the curvature of the cornea of a natural eye. This I trimmed with a knife to the diameter of the cornea, and to a thickness that would make it as light as possible while retaining the requisite firmness. Then I made the eyeball anæsthetic by applying two or three drops of a two to three per cent. solution of cocaine, and on fitting the cast over the cornea found that it held there perfectly, without pain or discomfort.



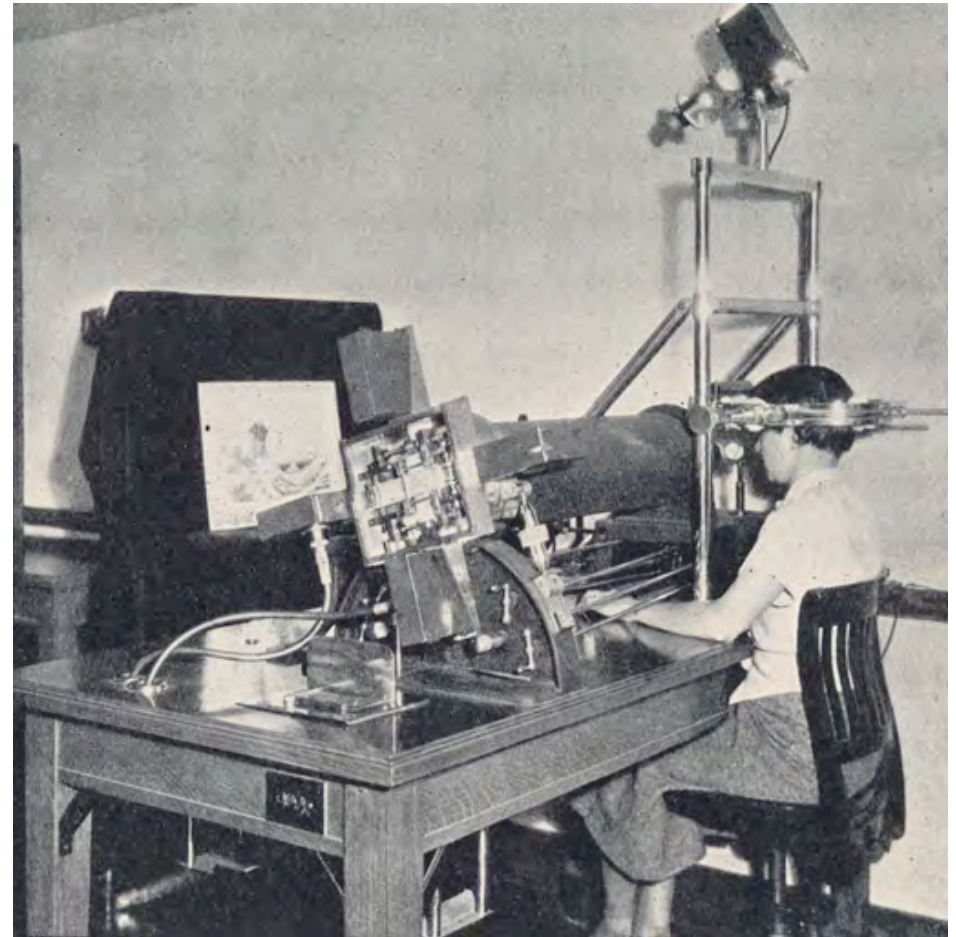
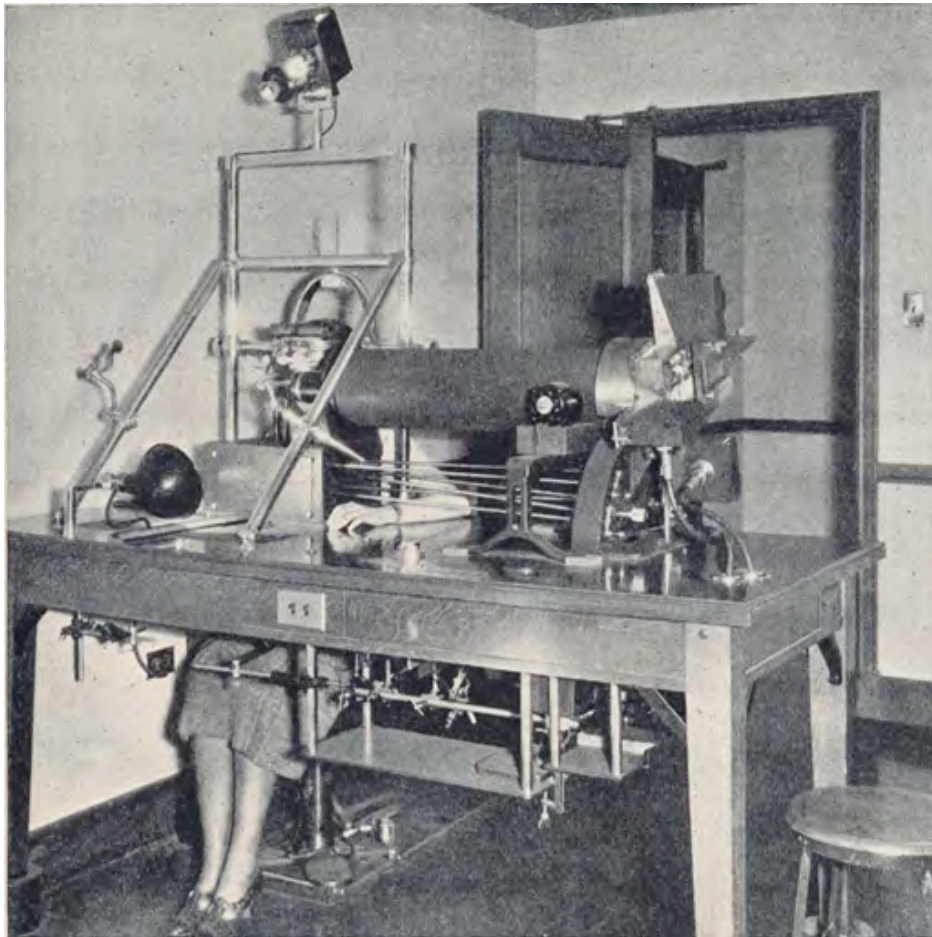
Delabarre (1898) *The American Journal of Psychology*



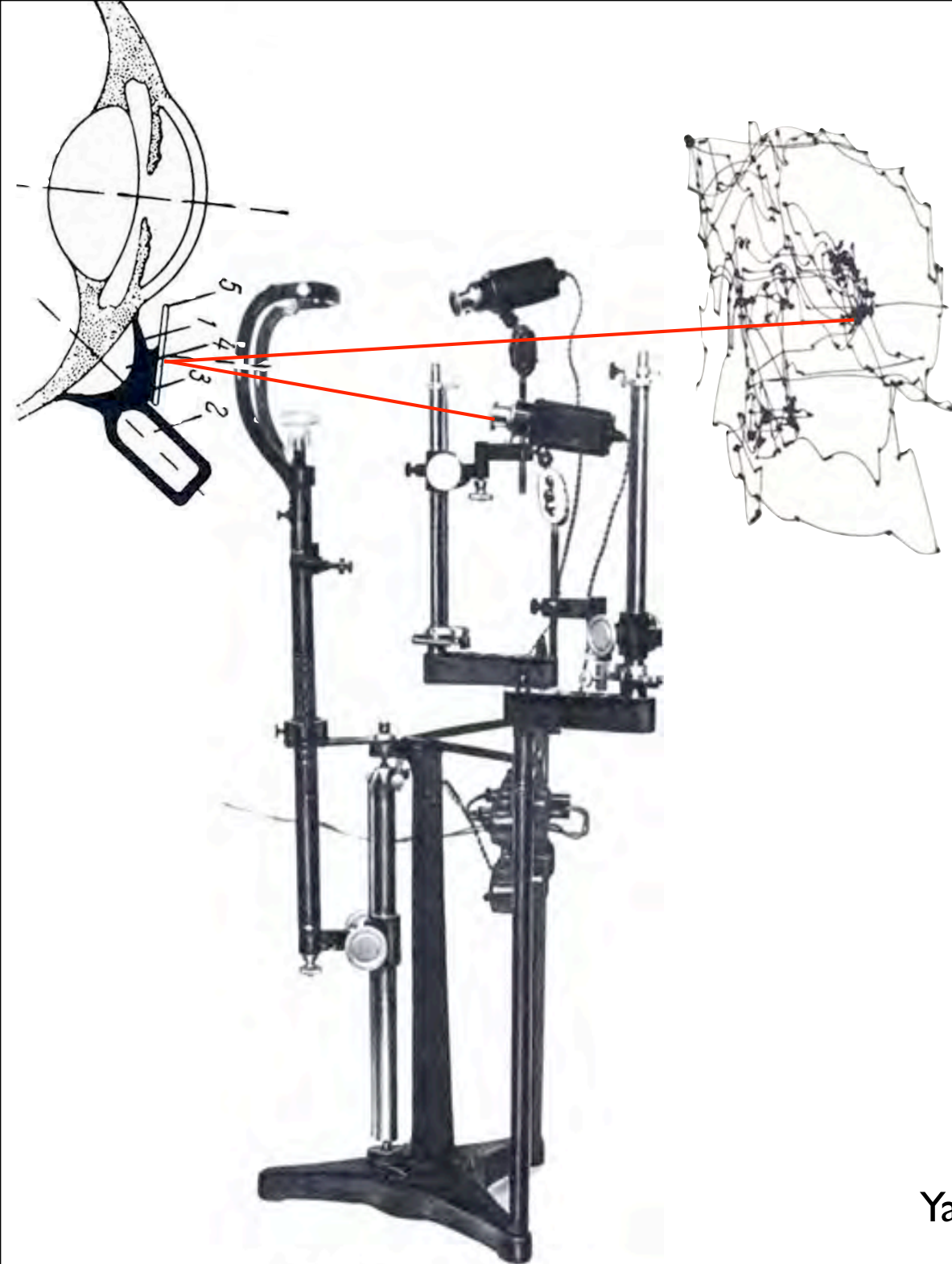
No trouble was experienced in getting the cup to stick for as long as was desired, when the lids were kept well separated ; indeed, it was somewhat difficult to remove it on several occasions. The experiments have so far been made on but two subjects — Prof. Hodge and myself. I am especially indebted to Prof. Hodge, as it has been difficult to get subjects ; partly from an exaggerated notion of the danger to the eye, partly from the defective vision of those who were otherwise available.

Huey (1898) *American Journal of Psychology*

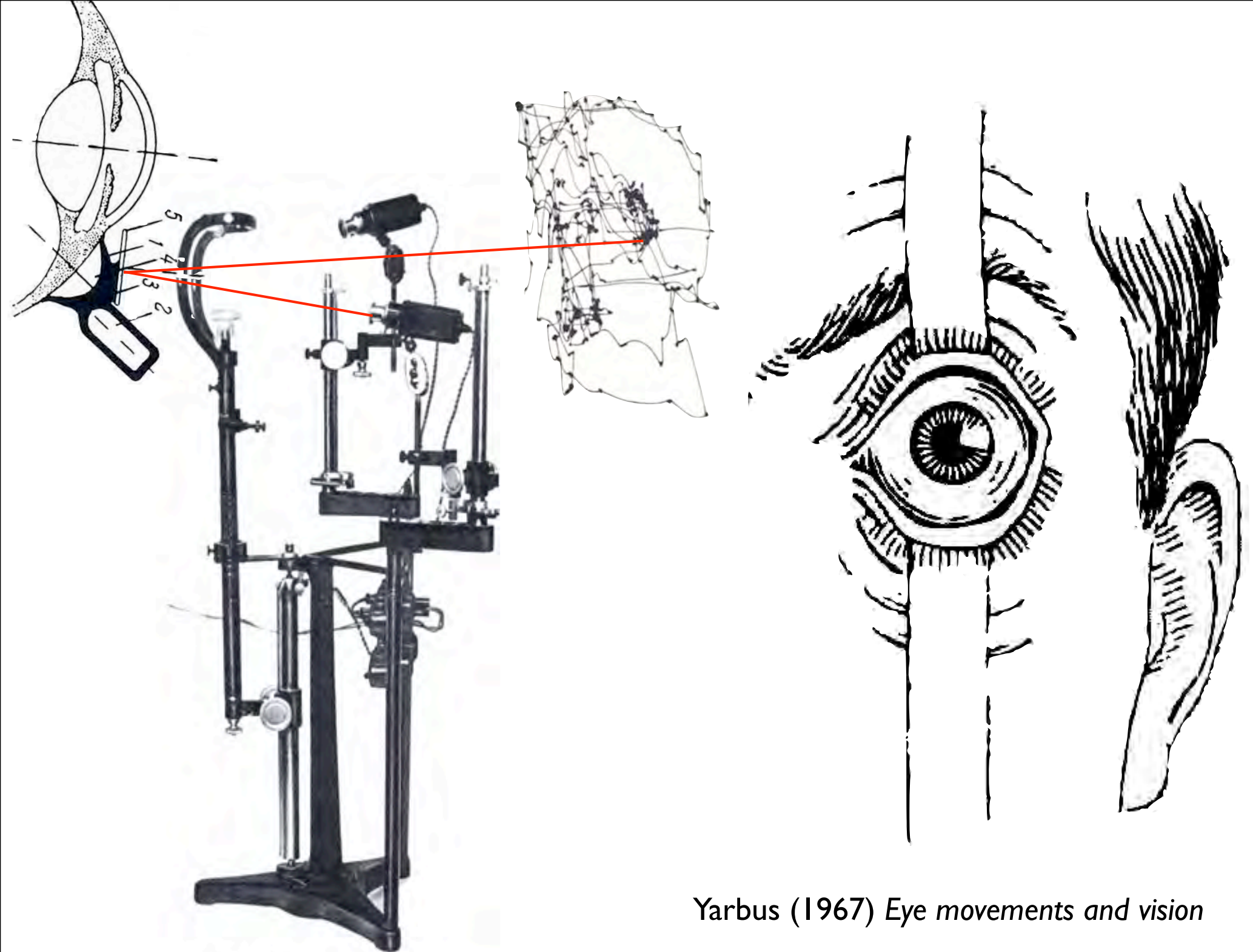
Corneal Reflection (CR) film-based eyetracker systems



Buswell (1935) *How people look at pictures*



Yarbus (1967) *Eye movements and vision*



Yarbus (1967) *Eye movements and vision*

Corneal Reflection (CR) Video-based eyetracker system

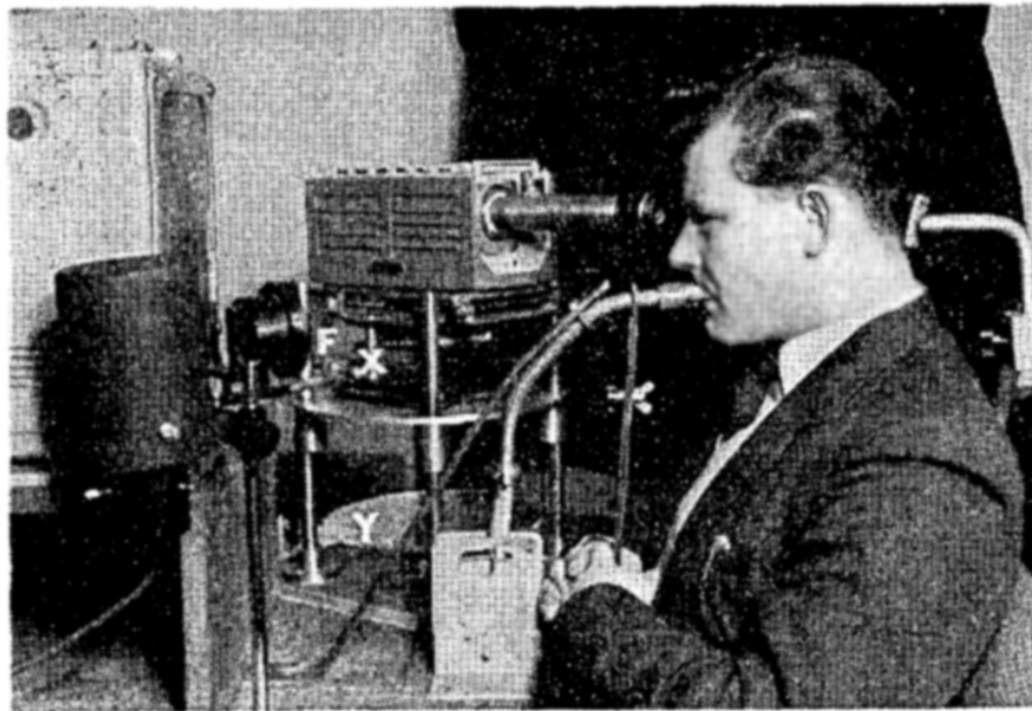


FIG. 1. General arrangement for eye camera.

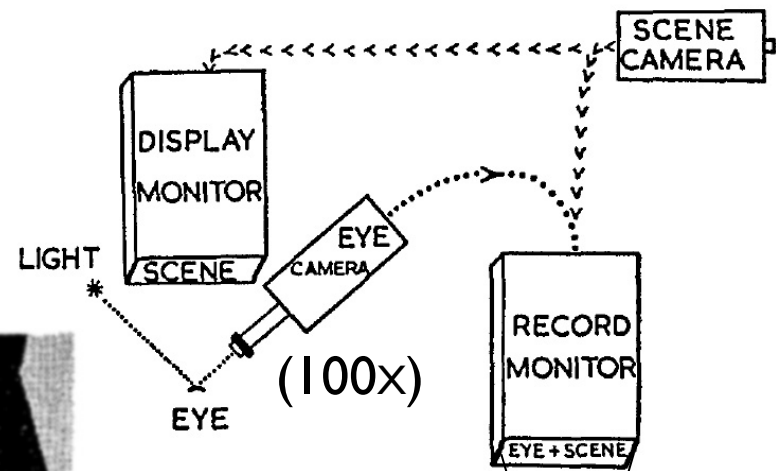


FIG. 2. Schematic vertical view.



6 fps 16mm

Mackworth & Mackworth (1958) JOSA

Electrooculograph (EOG) Video-based eyetracker system



Shackel (1960) *JOSA*

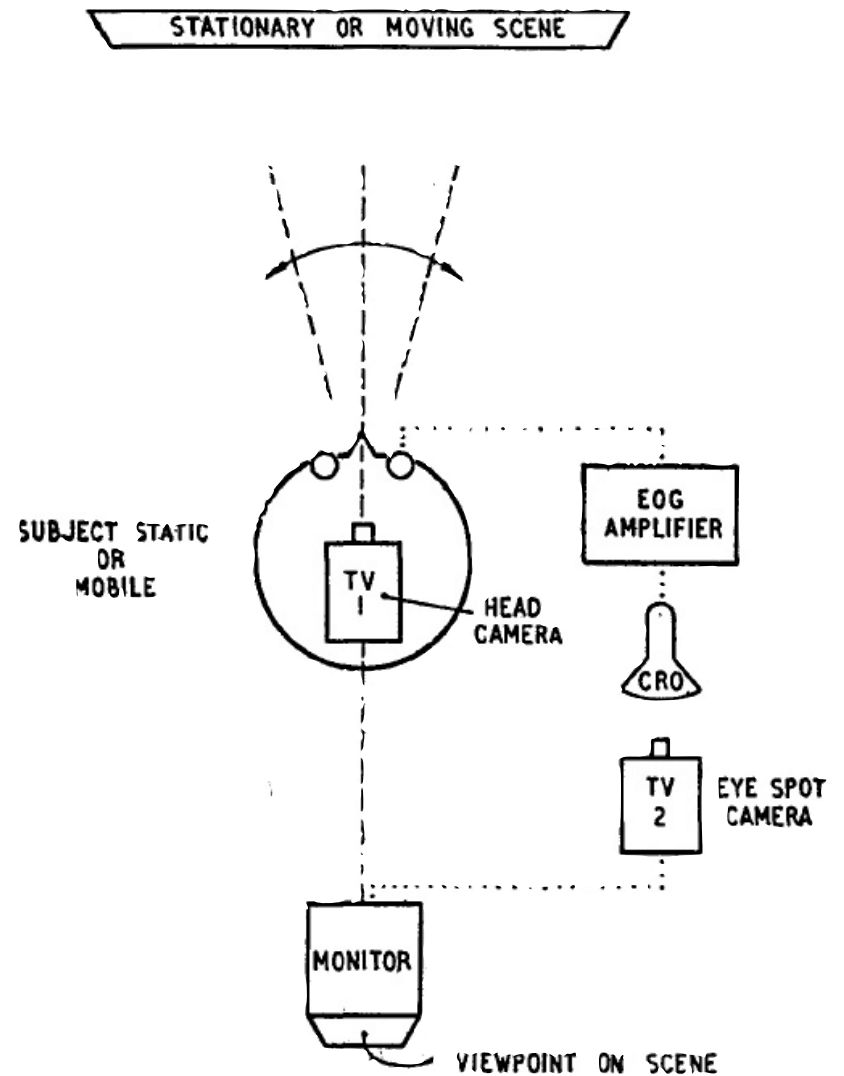


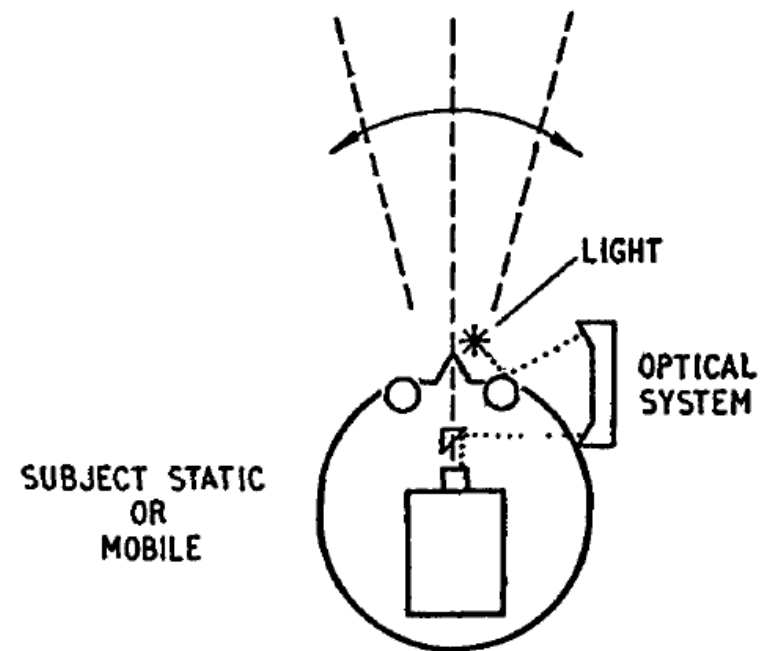
FIG. 2. Schematic diagram of method using EOG eyeball position recording.

Electrooculograph (EOG) Video-based eyetracker system



Shackel (1960) *JOSA*

STATIONARY OR MOVING SCENE



MOTION PICTURE OR TV HEAD CAMERA
VIEWPOINT SUPERIMPOSED ON SCENE BEFORE ENTERING FIELD LENS

FIG. 3. Sketch of principle applied to corneal-reflection eyeball position recording.

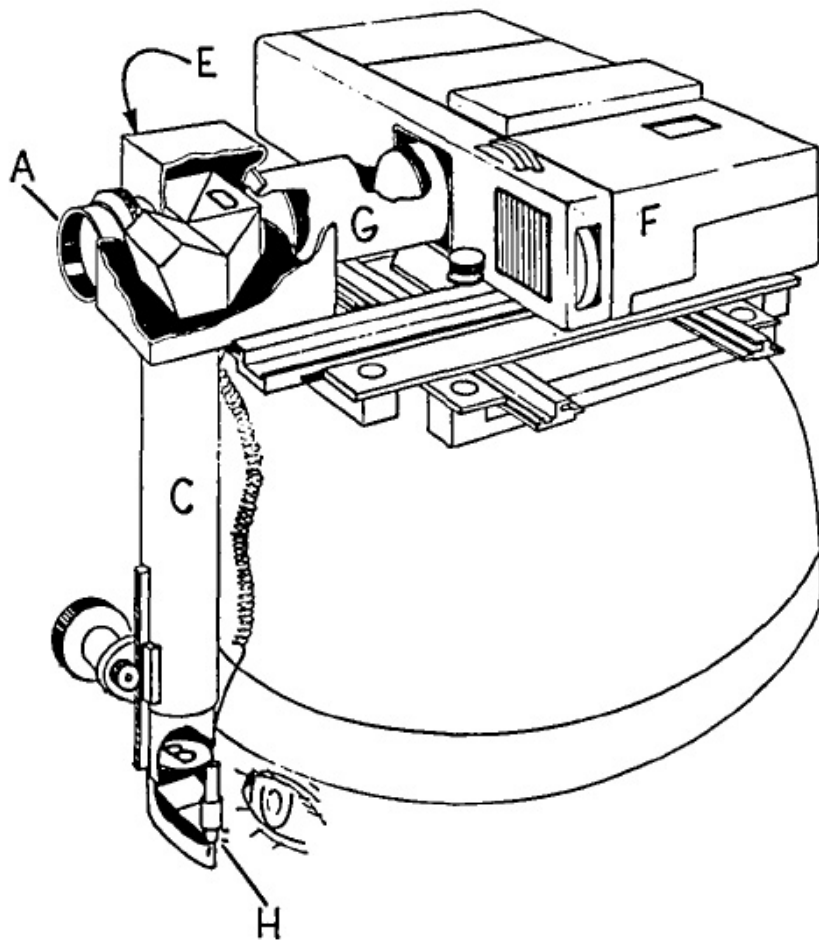


FIG. 1. Schematic diagram for head-mounted 8-mm movie camera.



FIG. 2. Head-mounted eye-marker camera.

Mackworth & Thomas (1962) *JOSA*

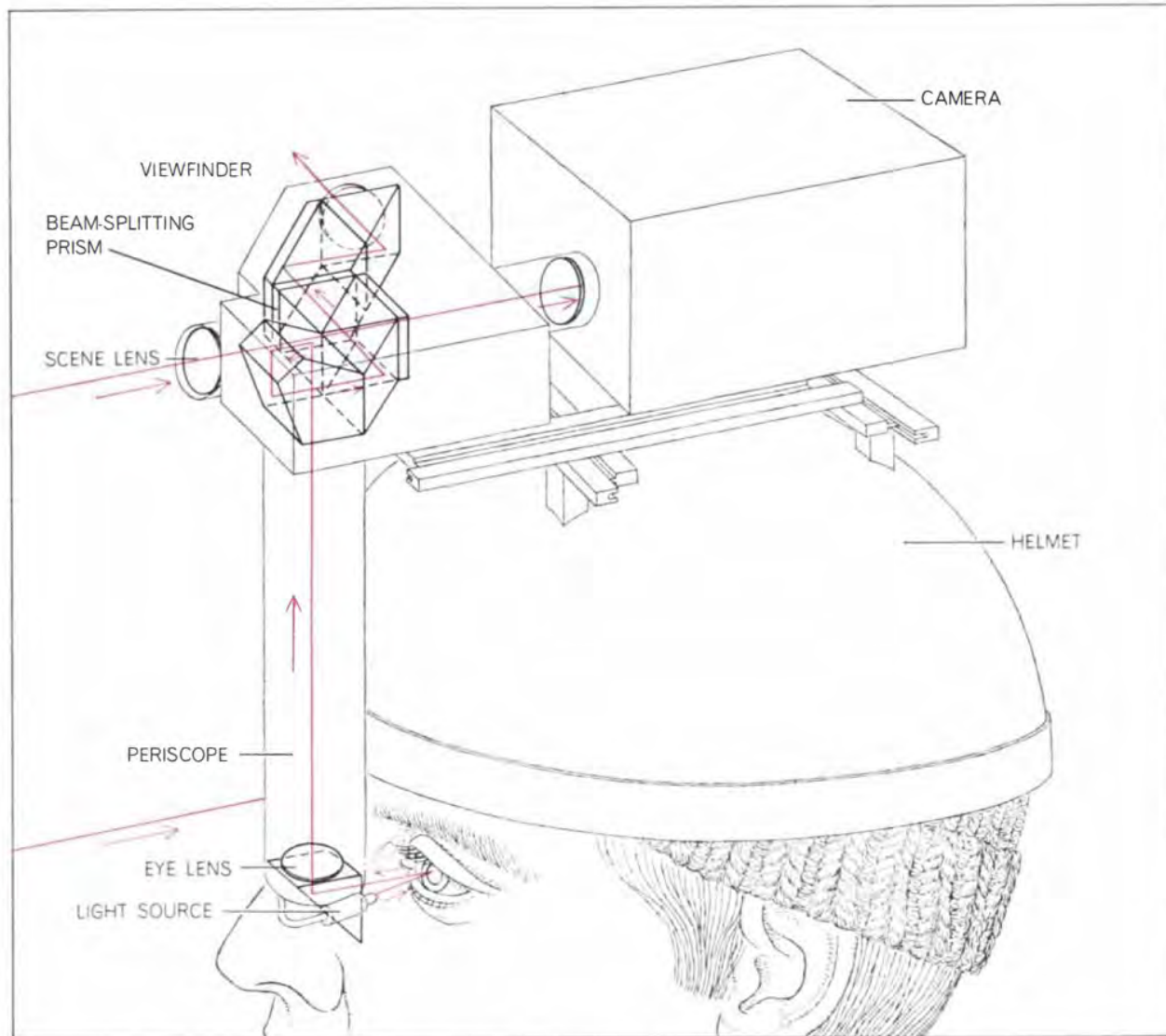
SCIENTIFIC AMERICAN



MOVEMENTS OF THE EYE

SEVENTY-FIVE CENTS

August 1968

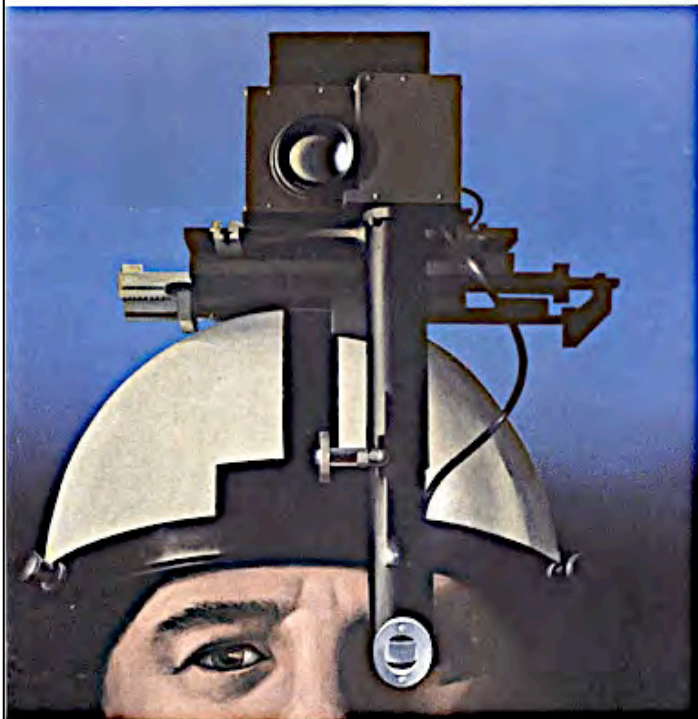


EYE-MARKER CAMERA tracks and records the eye's glance. The image of a spot of light, reflected from the cornea, is transmitted by an optical system in the periscope through a series of

prisms. This serves to superpose the eye-marker image on the scene image. The combined image can be monitored through the viewfinder as it is photographed by the motion-picture camera.

Thomas (1968) *Scientific American*

SCIENTIFIC AMERICAN



MOVEMENTS OF THE EYE

SEVENTY-FIVE CENTS

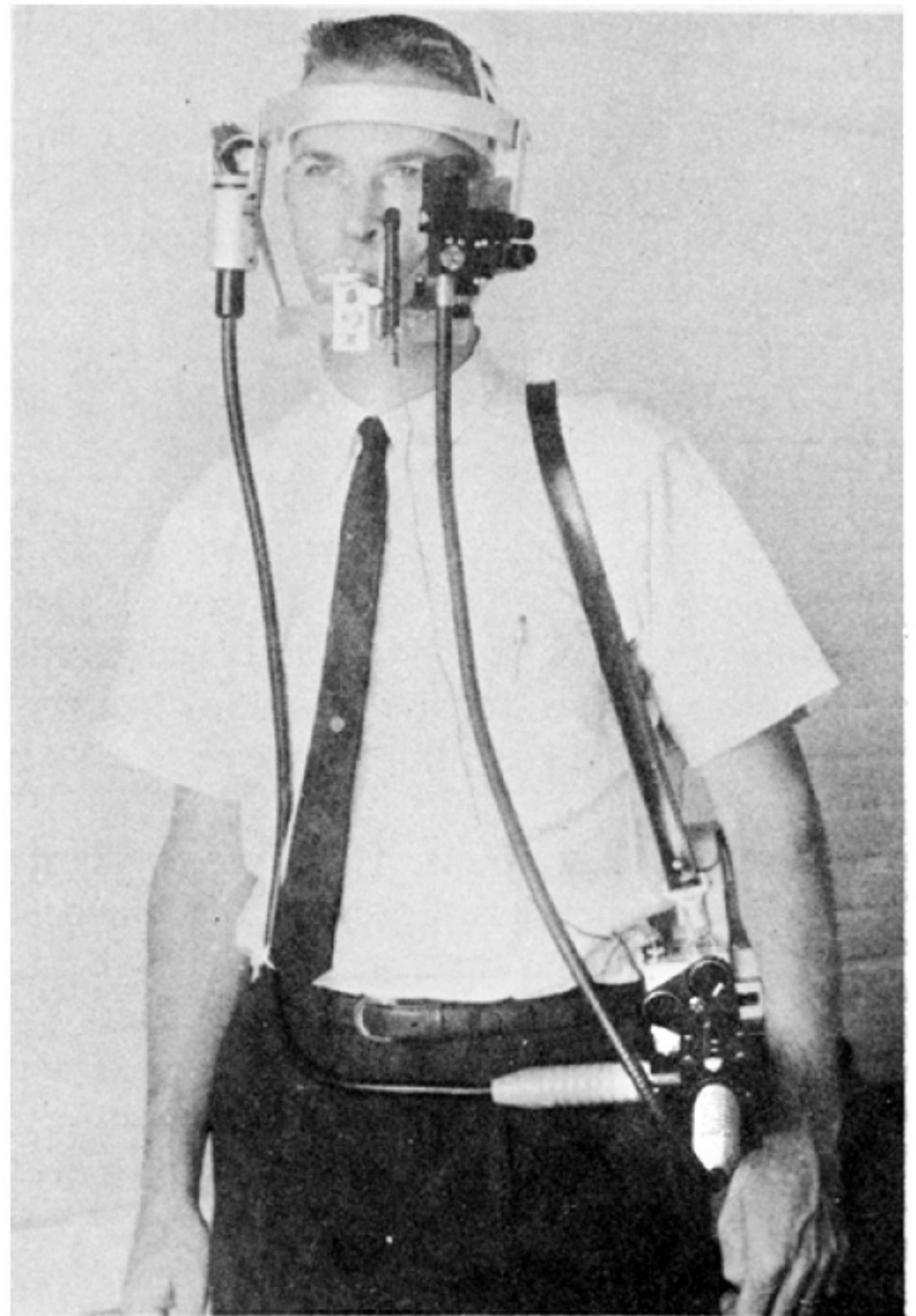
August 1968



Thomas (1968) *Scientific American*

Corneal-reflection film system with fiber-optic coupling

Young & Shea (1975) *BRMI*



Pupil - Corneal Reflection (P-CR) eyetracker systems

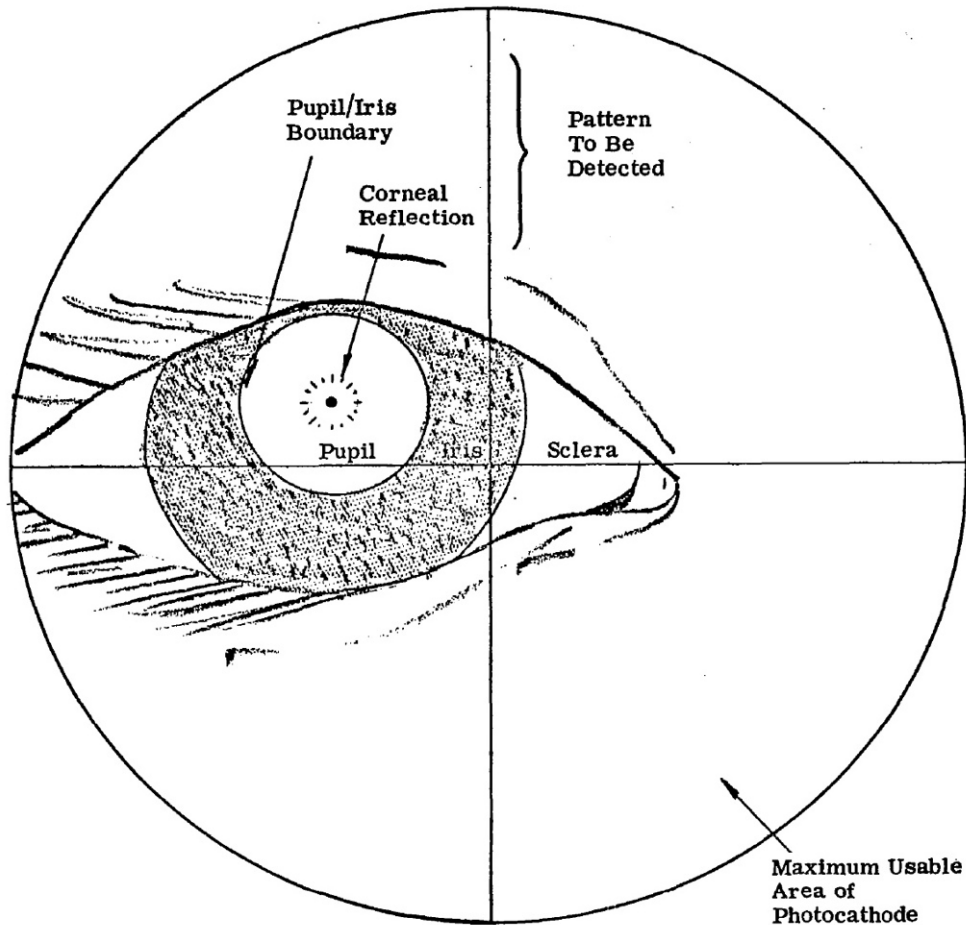


Figure 3.11 IMAGE OF EYE ON PHOTOCATHODE

Merchant (1967) NASA Tech Report CR-805



Figure 1 OPTOMECHANICAL UNIT

Merchant (1969) NASA Tech Report CR-1422

Pupil - Corneal Reflection (P-CR) eyetracker systems

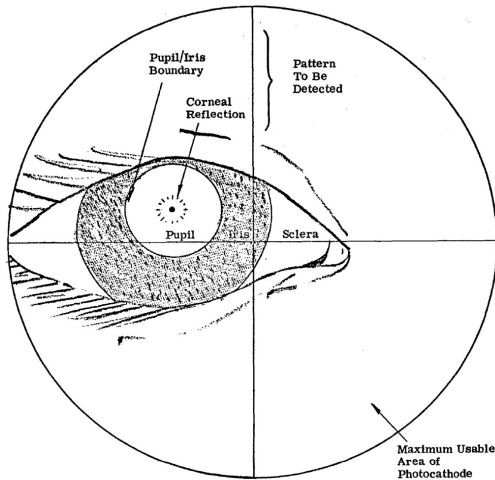
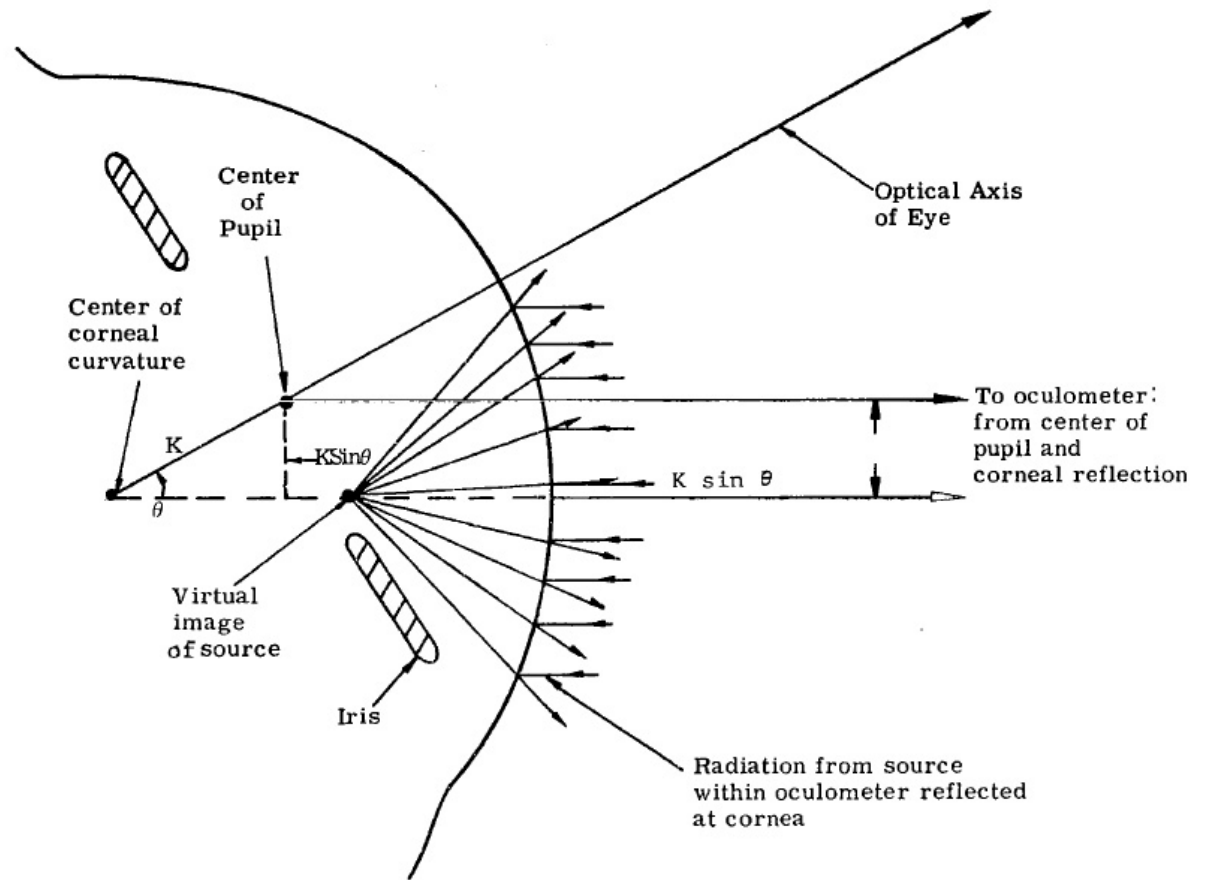


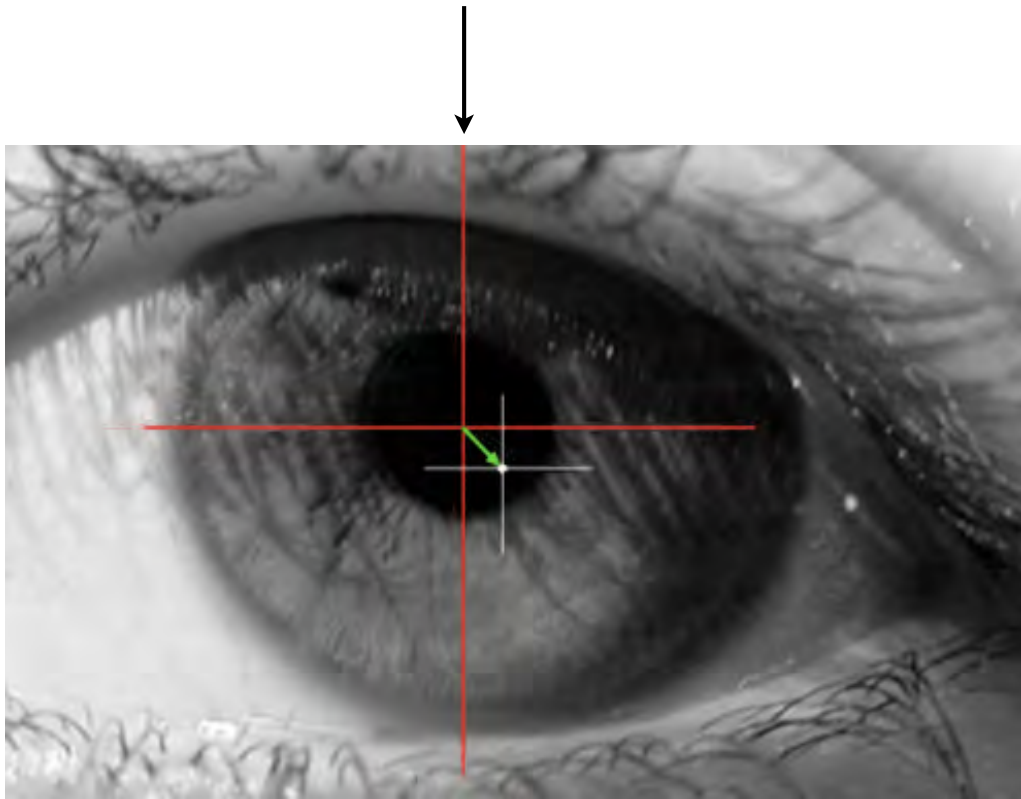
Figure 3.11 IMAGE OF EYE ON PHOTOCATHODE



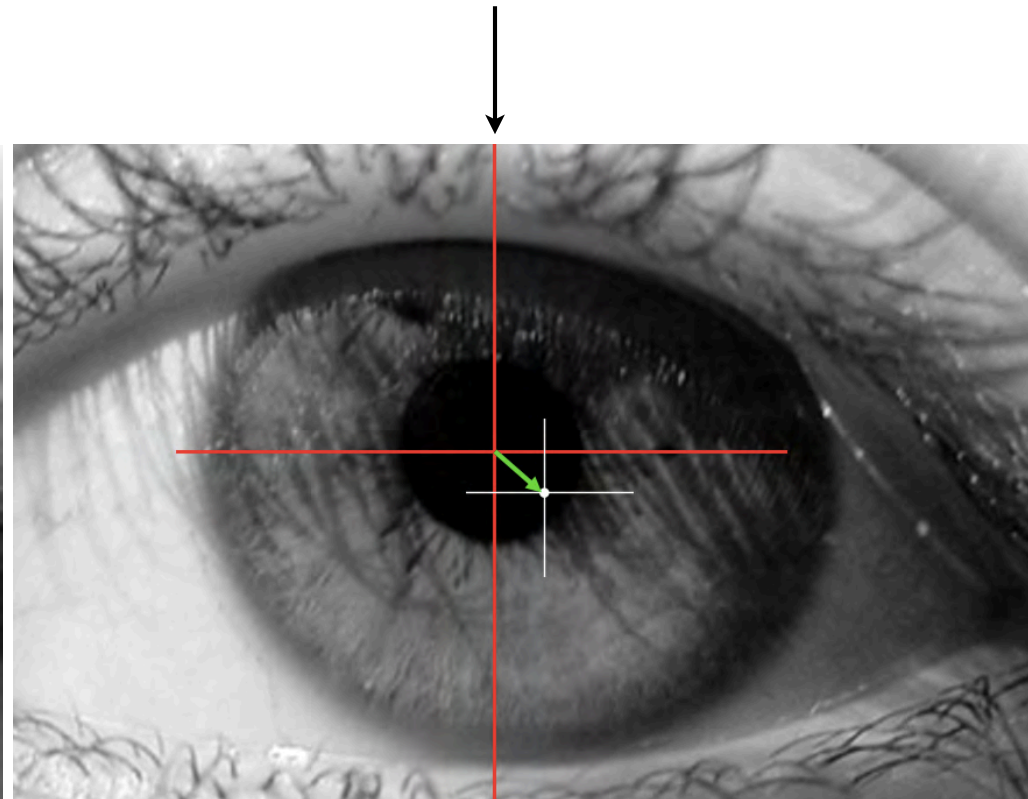
Displacement of corneal reflection from center of pupil, $K \sin \theta$, is proportional to the angular direction, θ , of the eye, and is independent of the position of the eye.

Merchant (1969) NASA Tech Report CR-1422

Pupil - Corneal Reflection (CR) eyetracker systems

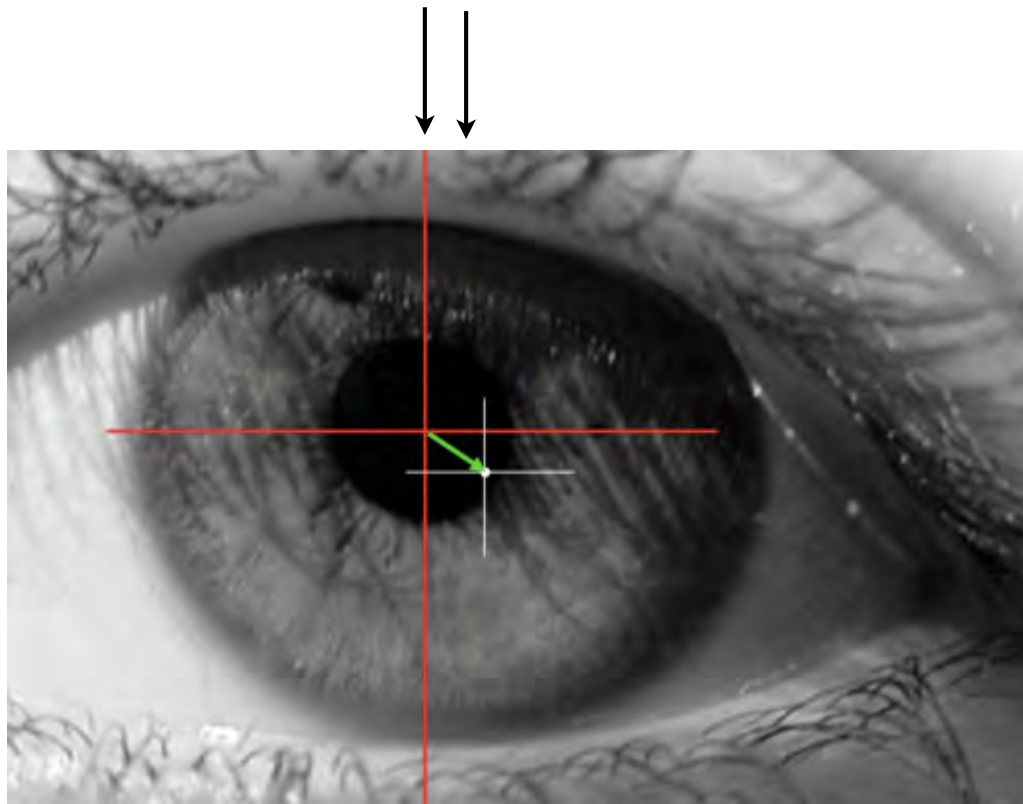


**Eye movement
(rotation)**

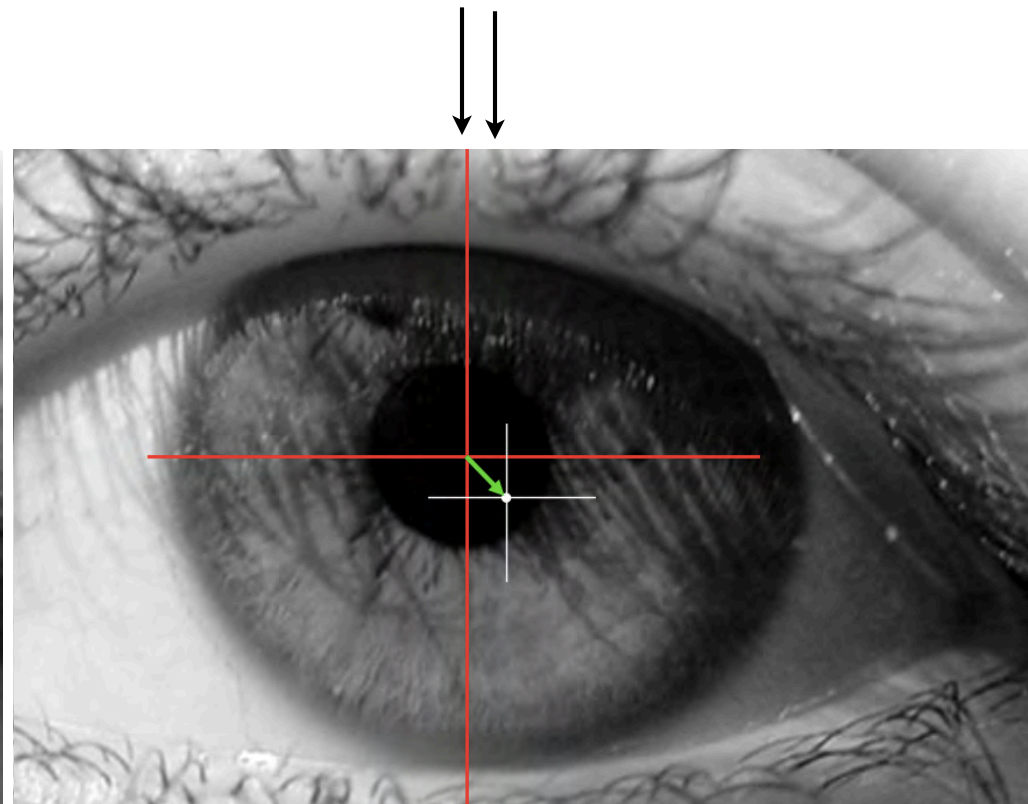


**Camera movement
(translation)**

Pupil - Corneal Reflection (CR) eyetracker systems

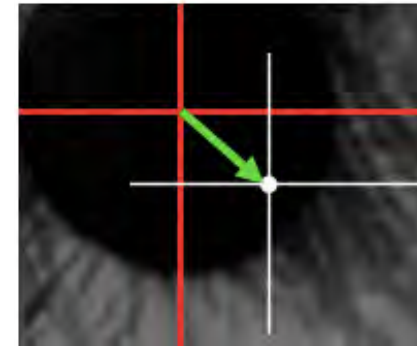
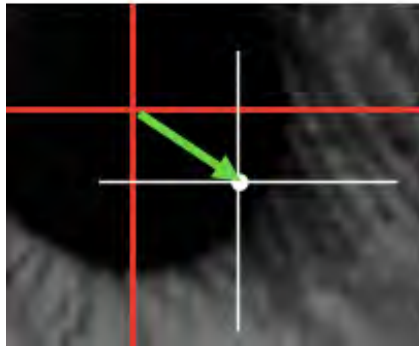
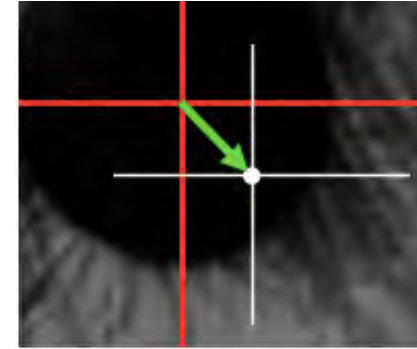
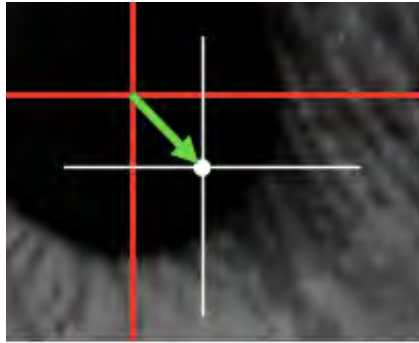


**Eye movement
(rotation)**



**Camera movement
(translation)**

Pupil - Corneal Reflection (CR) eyetracker systems



Eye movement
(rotation)



Camera movement
(translation)



Pupil - Corneal Reflection (CR) eyetracker systems

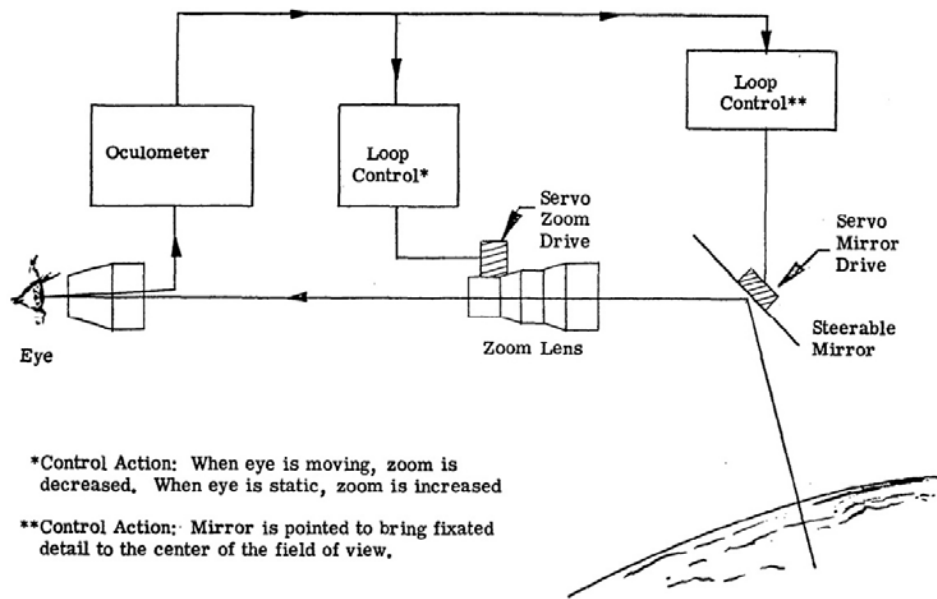


Figure A.2 ASTRONAUT'S EYE-CONTROLLED TRACKING TELESCOPE

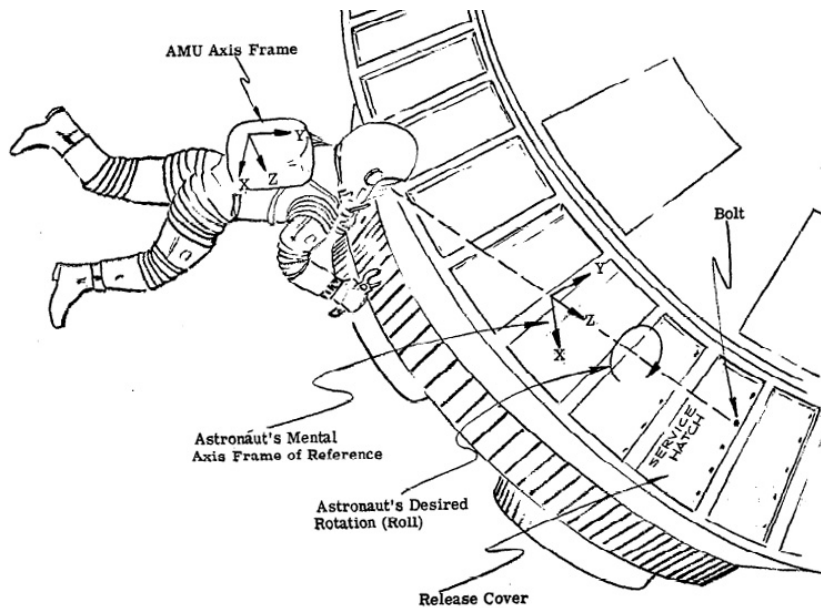


Figure A.11 ASTRONAUT DESIRES TO ROLL IN HIS OWN AXIS FRAME

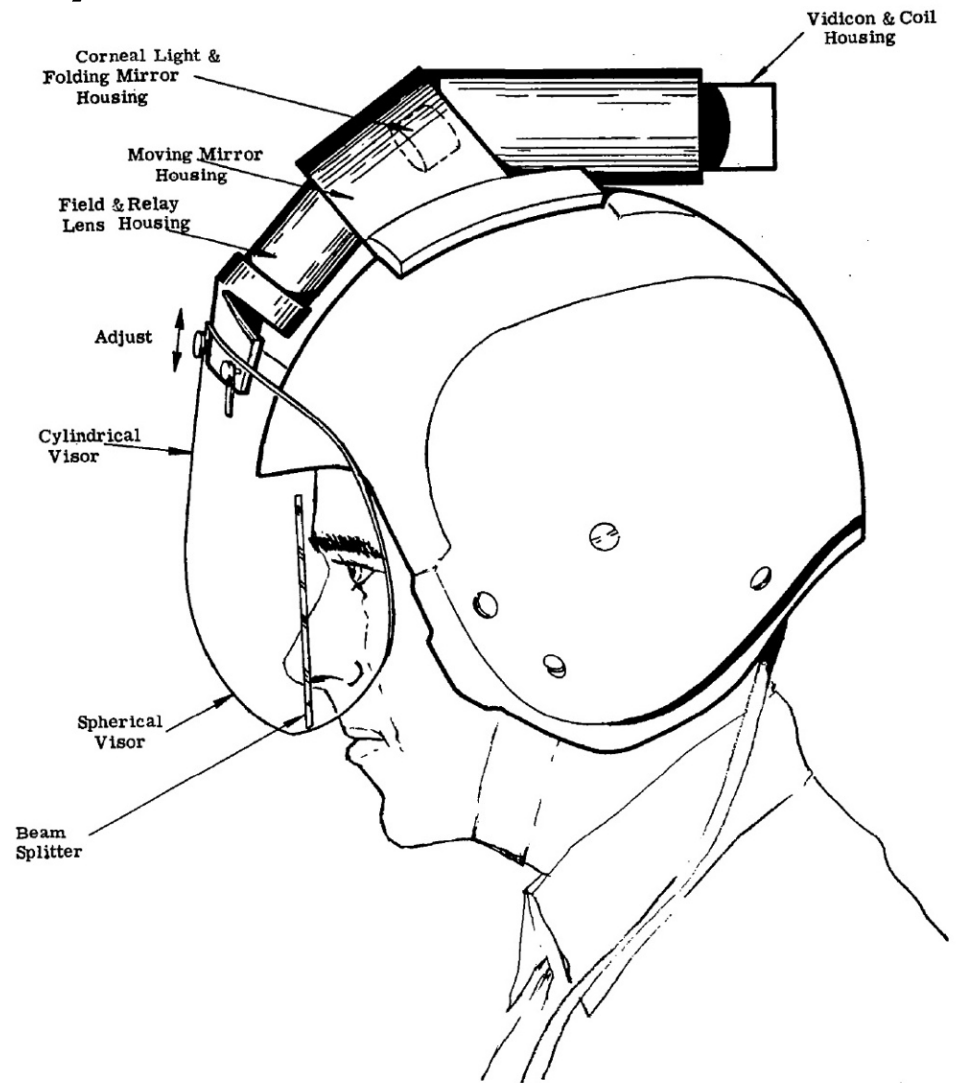


Figure A.1 CONFIGURATION OF HELMET-MOUNTED OCULOMETER

Merchant (1967) NASA Tech Report CR-805

Pupil - Corneal Reflection (CR) Video-based eyetracker systems (Merchant - 1974)

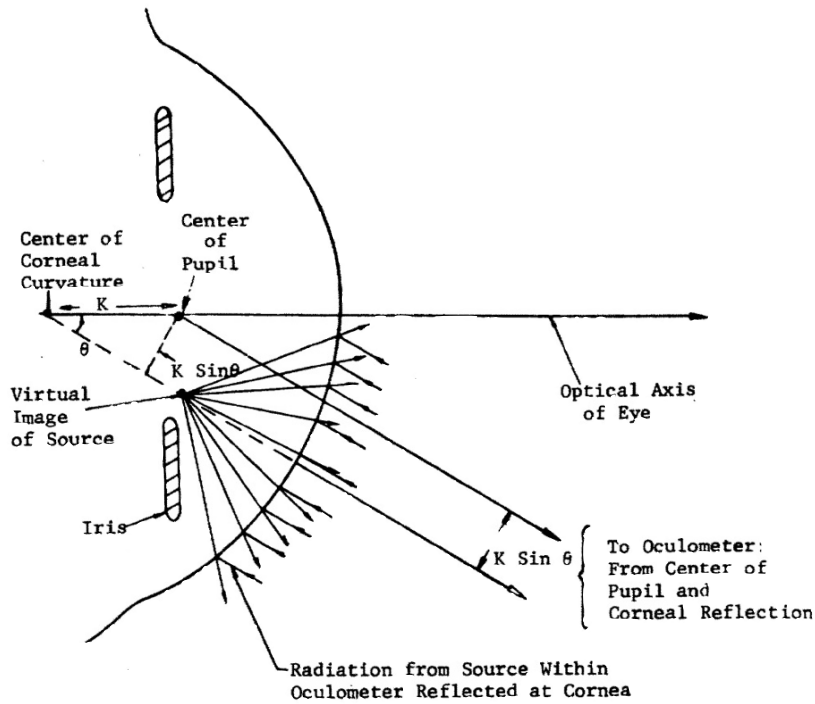


Fig. 5. Basic sensing principle. Displacement of the corneal reflection from the center of the pupil by $K \sin \theta$ is proportional to the angular direction θ of the eye, and is independent of the position of the eye.

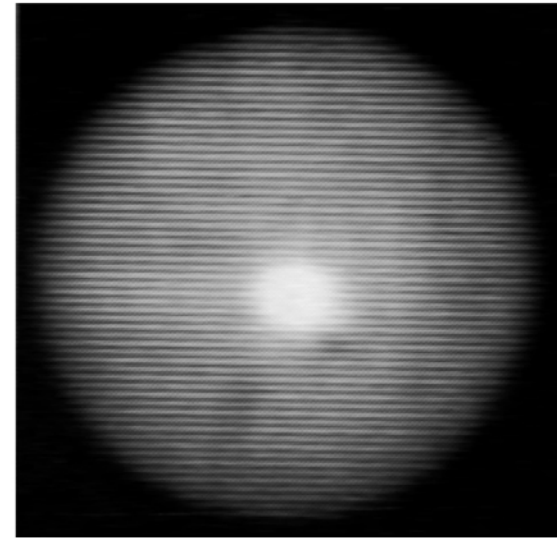


Fig. 7. TV picture of the eye.

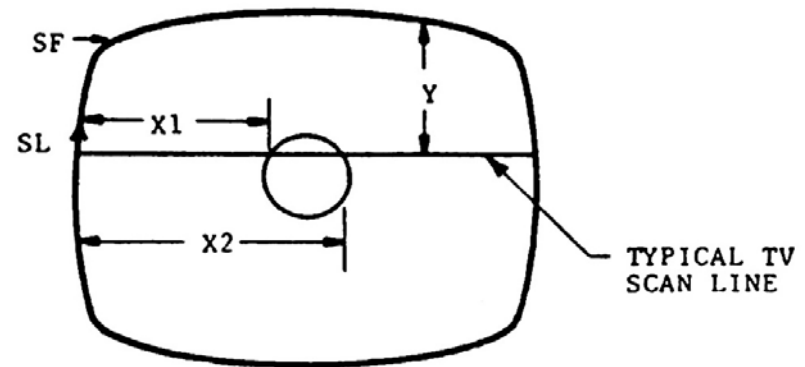
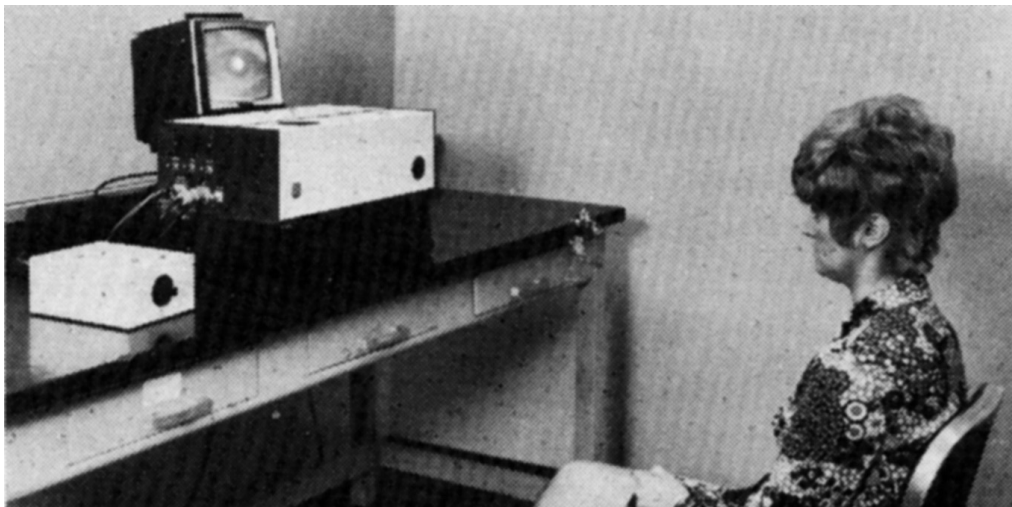


Fig. 8. Digital eye coordinates.

Merchant, Morrissette, & Porterfield (1974) *IEEE Trans Biomed Eng*

Pupil - Corneal Reflection (CR) Video-based eyetracker systems (Merchant - 1974)



Merchant, Morrissette, & Porterfield (1974) *IEEE Trans Biomed Eng*

Pupil - Corneal Reflection (CR) Video-based eyetracker systems



Arrington



ASL



Dikablis



EyeLink



Positive
Science



FaceLab



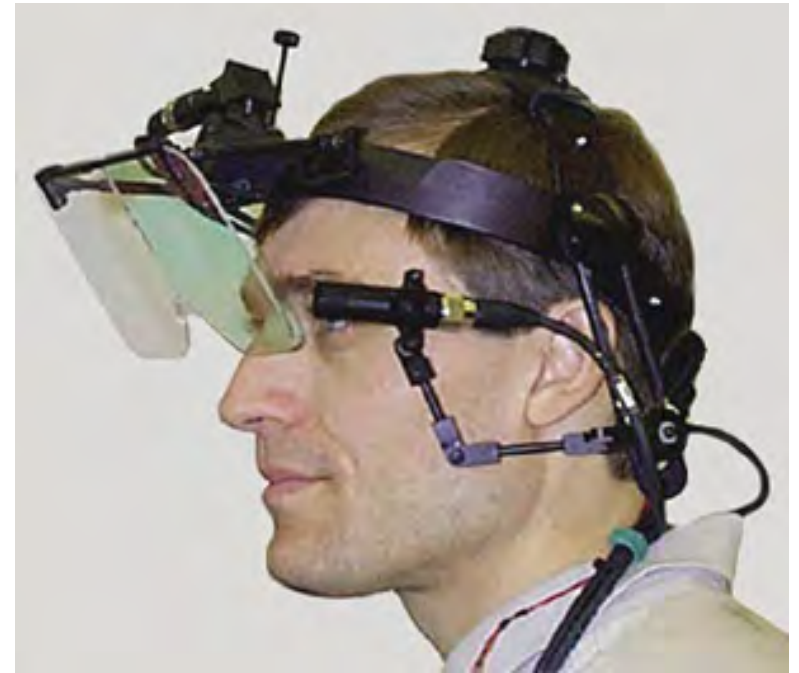
mirametrix



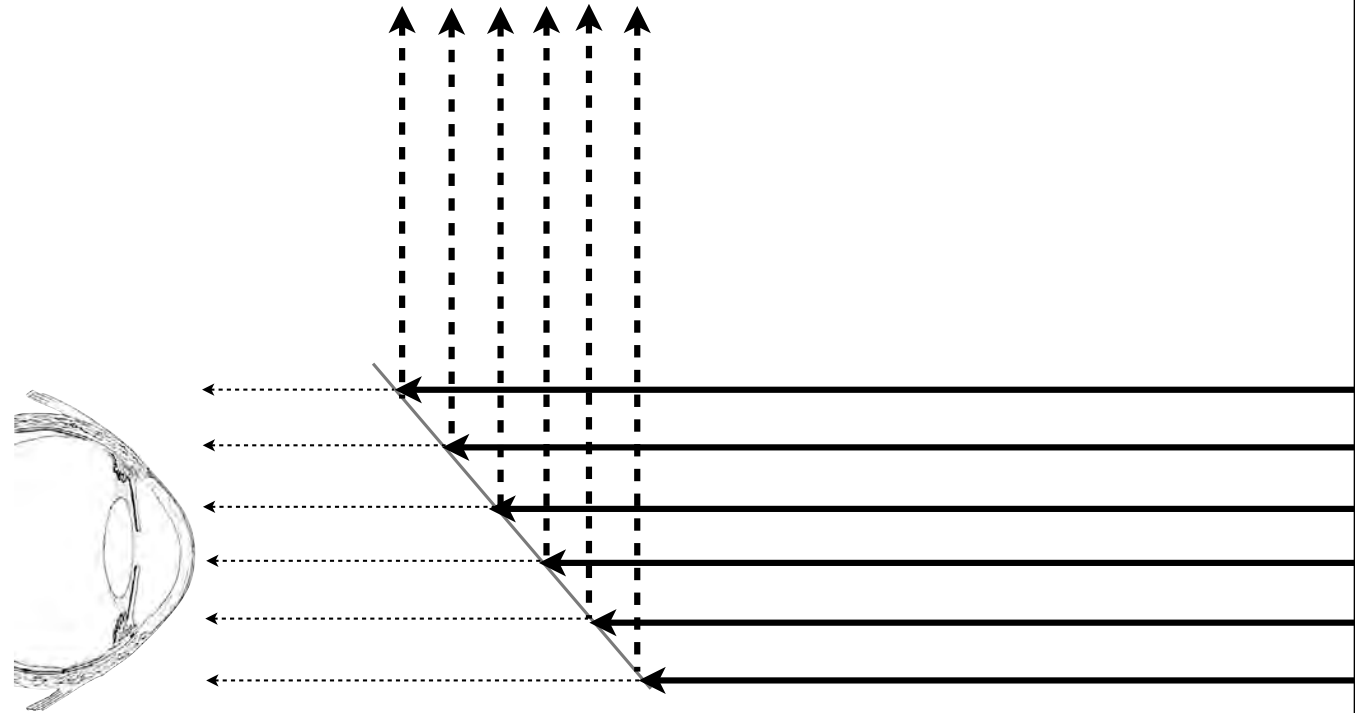
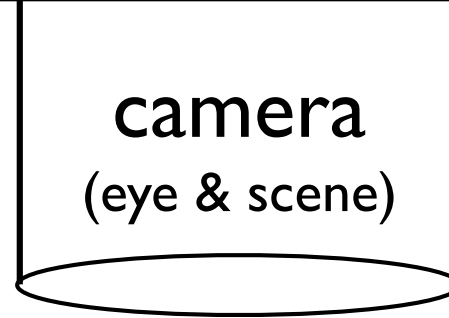
SMI

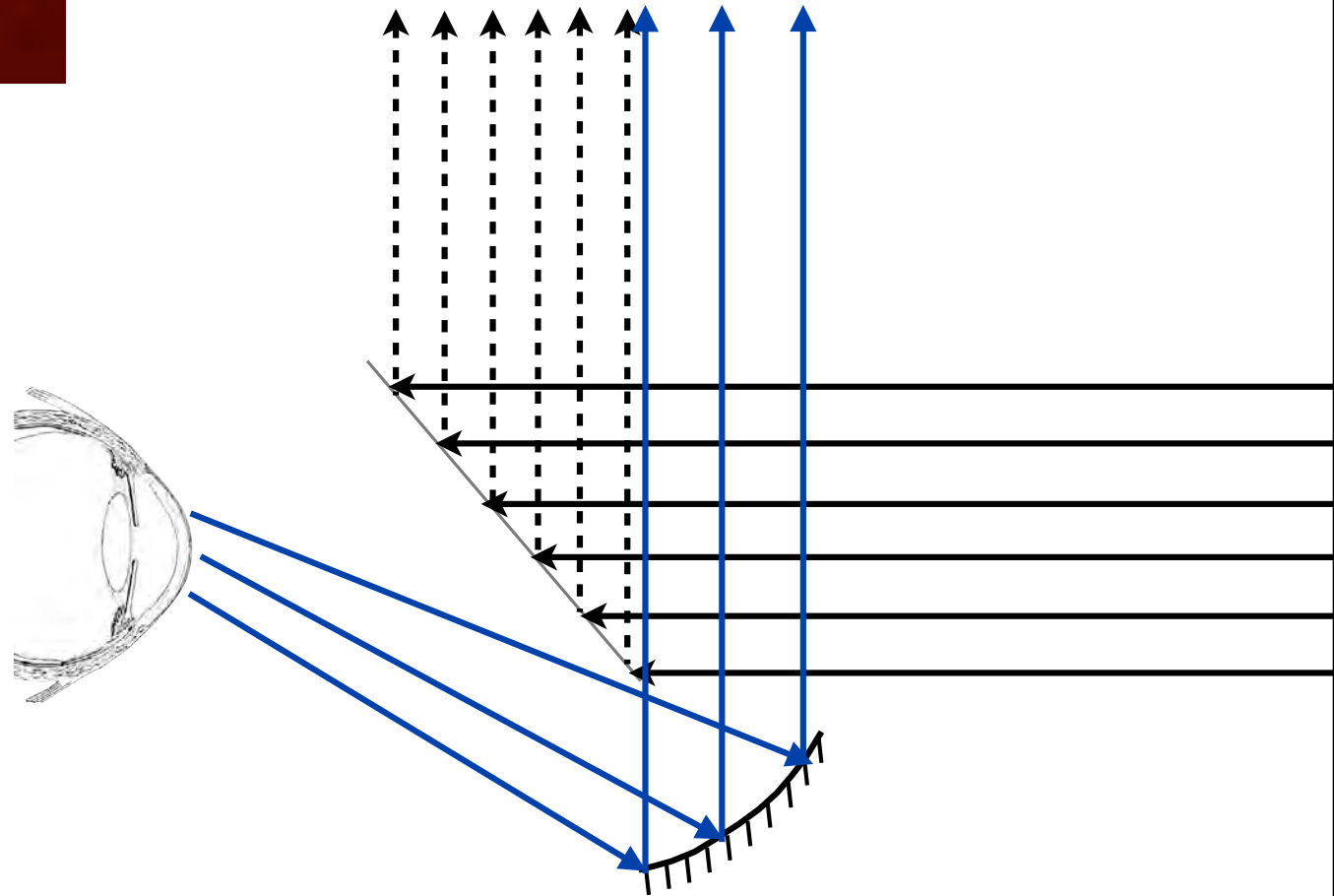
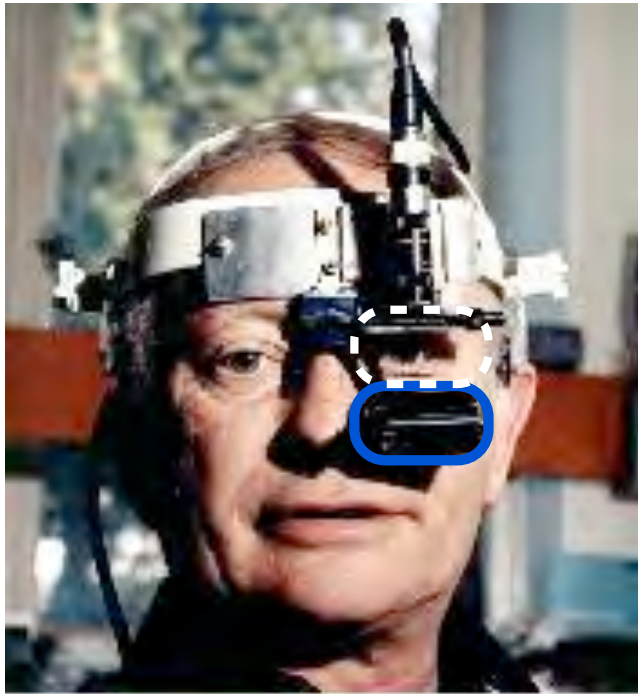
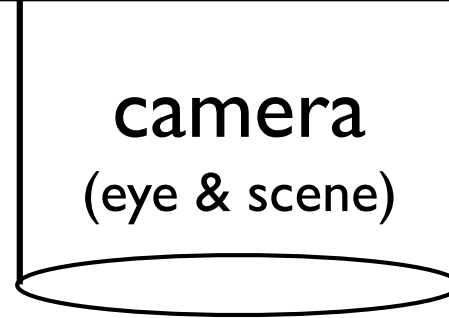


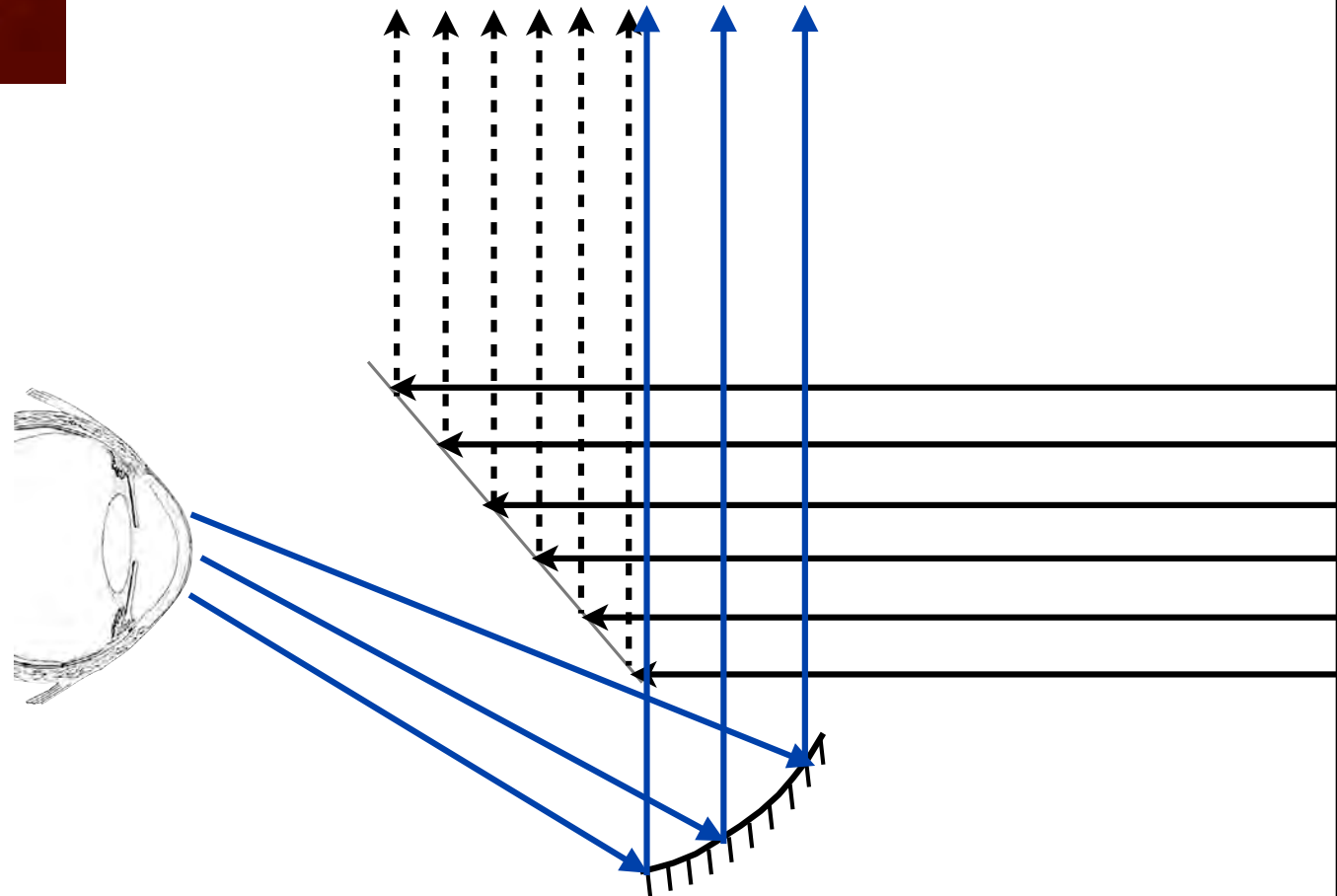
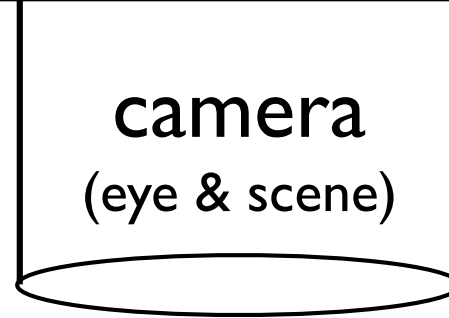
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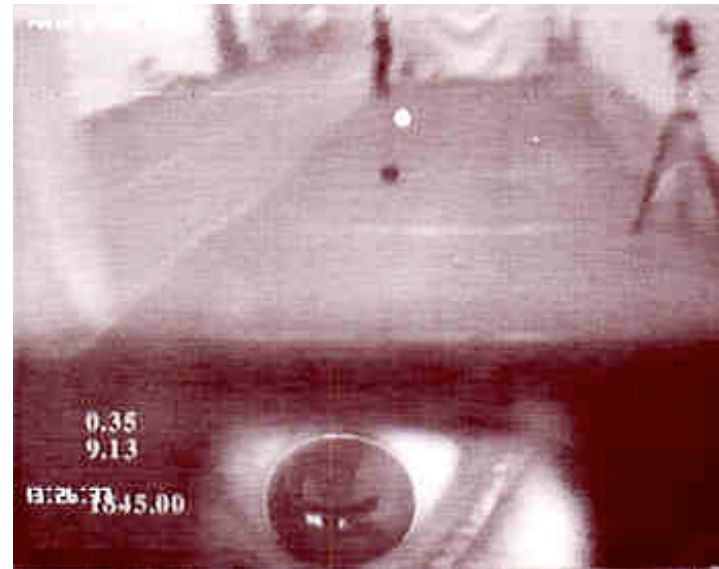
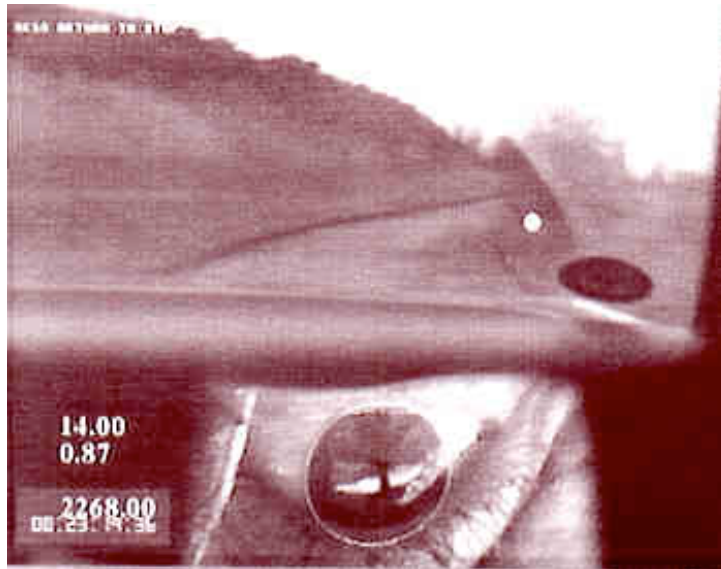


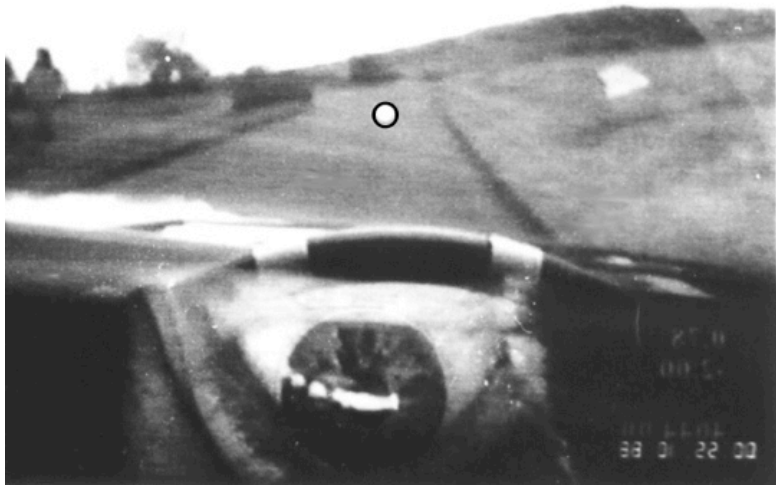
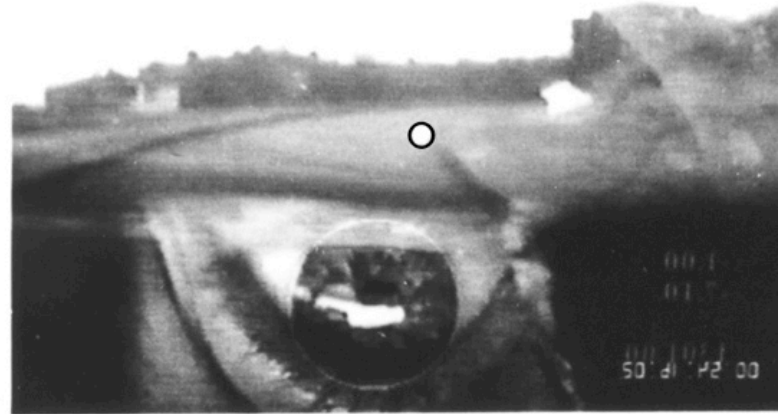
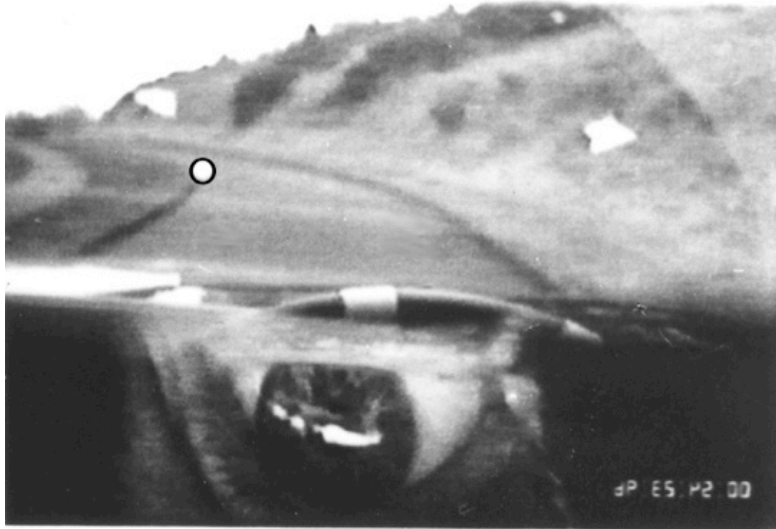












RIT Wearable Eyetracker

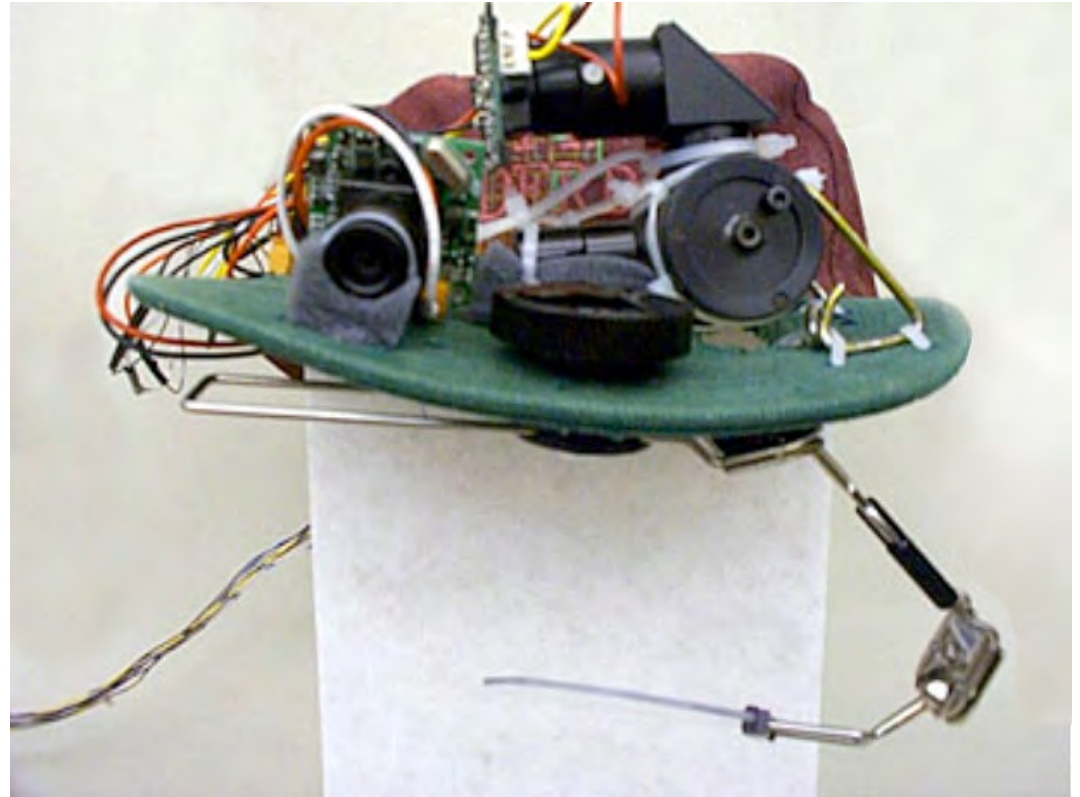


“0th Generation” (1996)

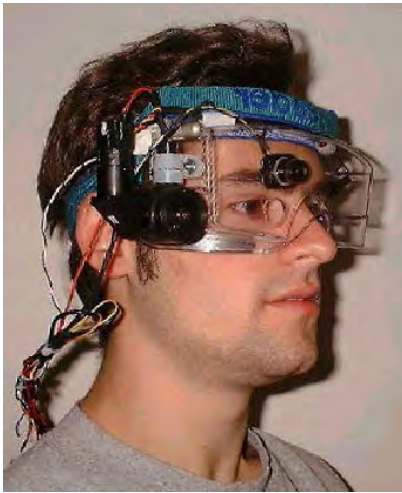
RIT Wearable Eyetracker



1st Generation (1998)



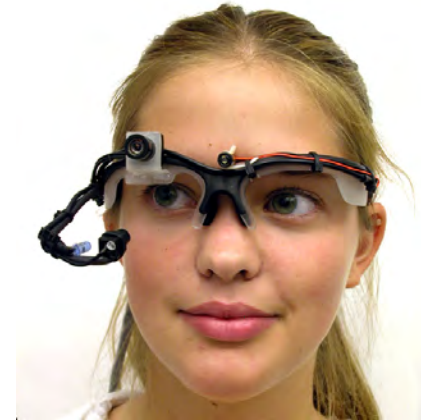
RIT Wearable Eyetracker



2nd (2000)



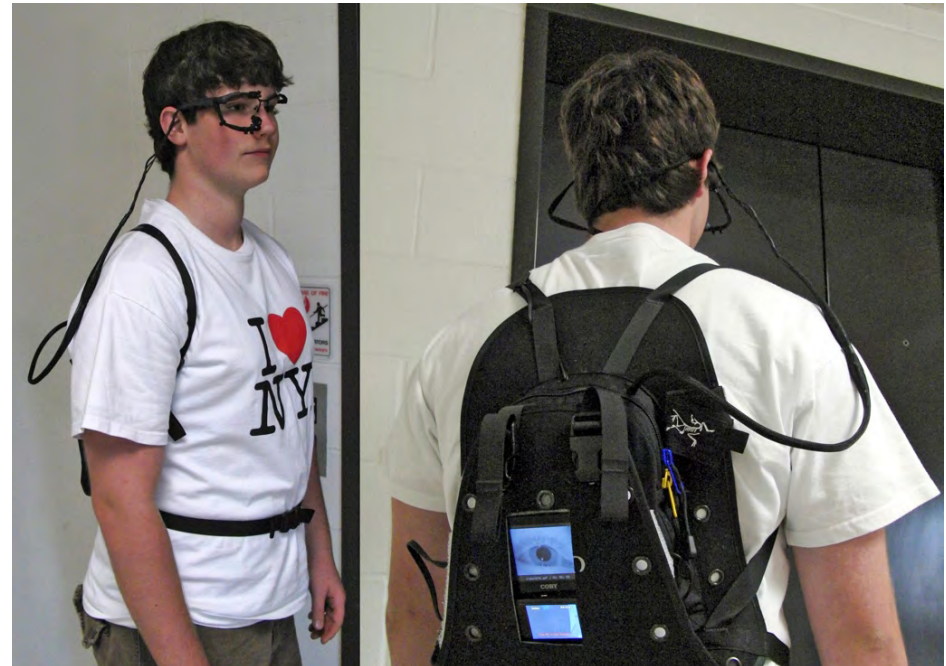
3rd (2003)



4th (2004)



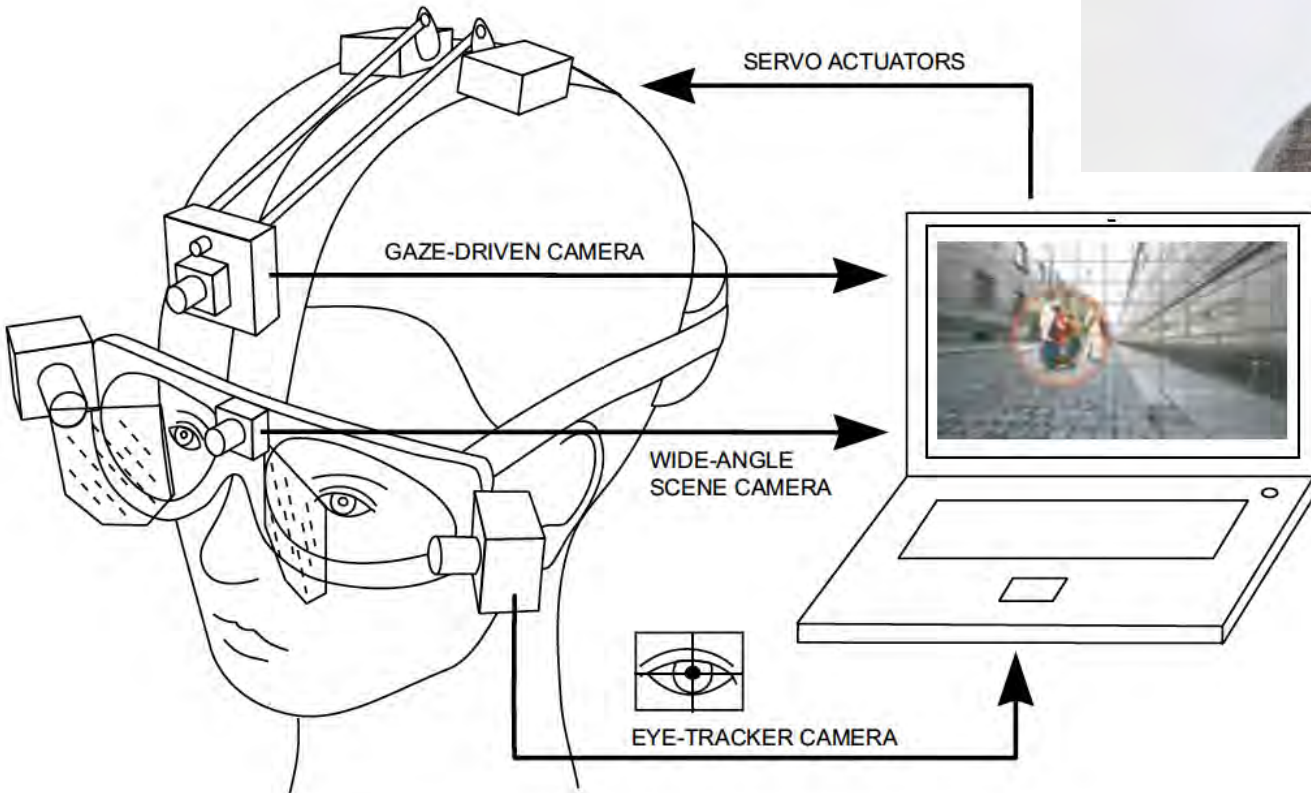
5th (2006)



6th (2008)

Positive Science™ Wearable Eyetracker





EyeSeeCam



Tobii Glasses (IR markers)





SMI IView X



SMI Glasses



ASL MobileEye XG



Dong & Luo, PETMEI 2011



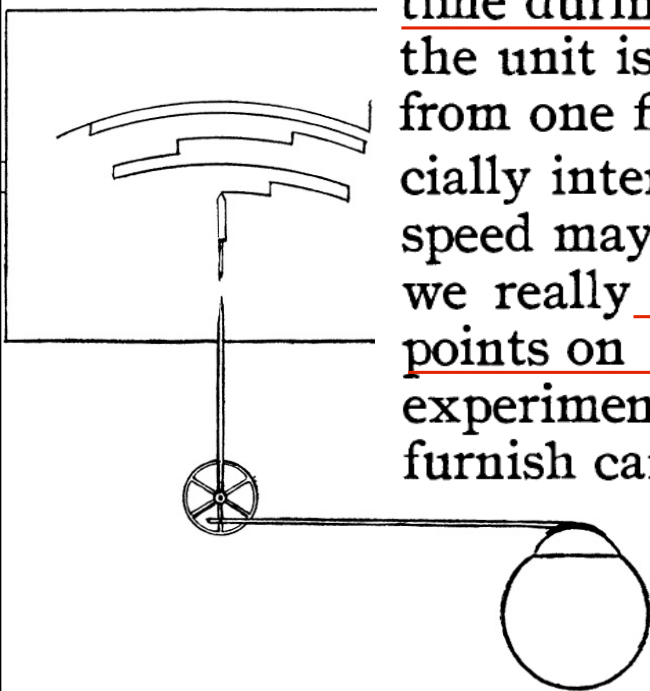
WearCam

Data Analysis:

Besides, the most casual observation showed that the eye moved along the line by little jerks and not with a continuous steady movement. I tried to record these jerks by direct observation, but finally decided that my simple reaction to sight stimuli was not quick enough to keep up with them when the subject read at normal speed.

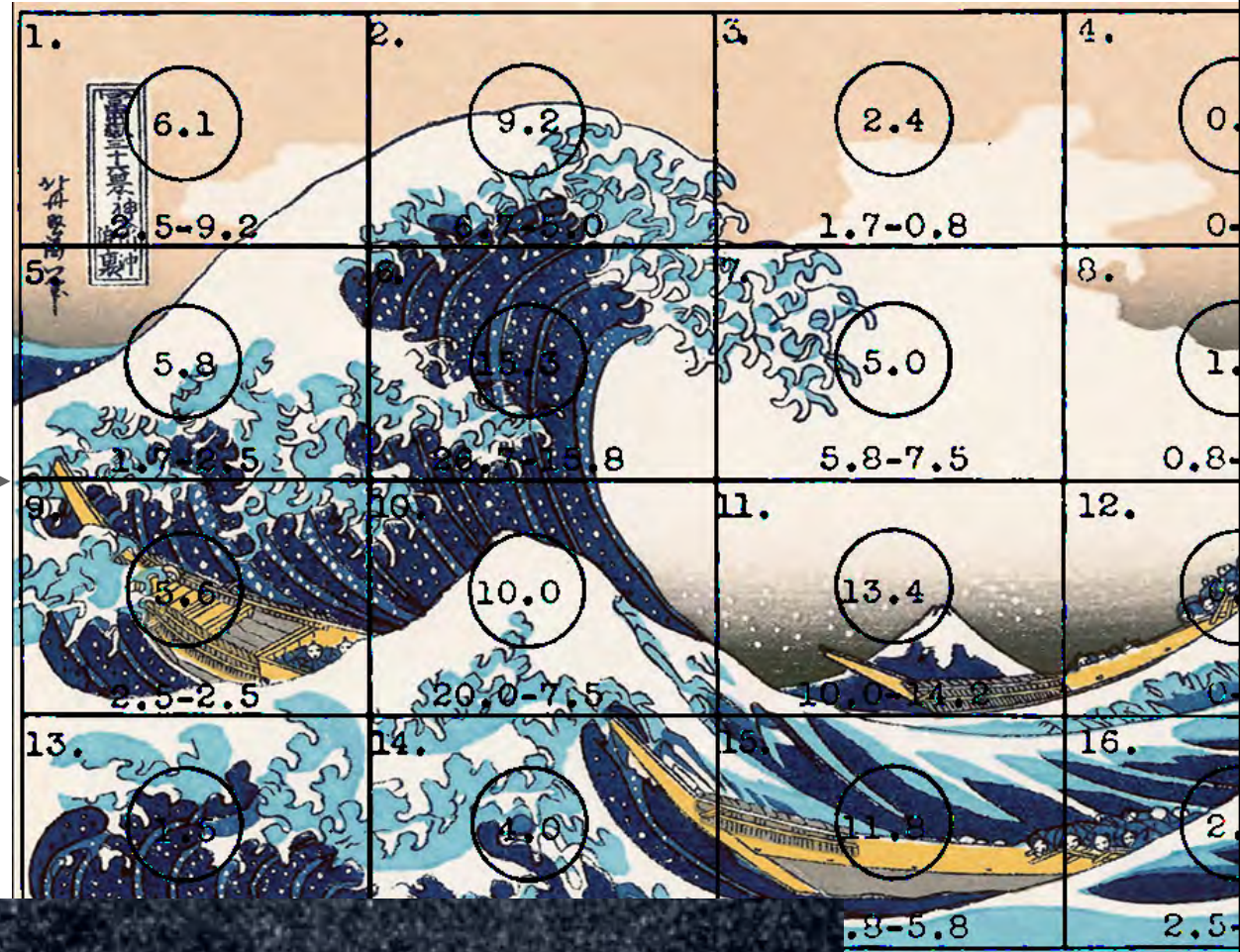
...

By the help of the quarter-second record written on the margin of the paper, it is possible to measure approximately the time during which the eye remains fixated at each point, but the unit is too large for getting the speed with which it moves from one fixation point to another.¹ The latter point is especially interesting, as it would seem from the curves that the speed may be so great that the retinal impressions fuse and that we really do not see foveally what we read except at the few points on the ordinary line at which the eye pauses. These experiments are as yet incomplete; and the data which they furnish cannot be arranged in time for this report.

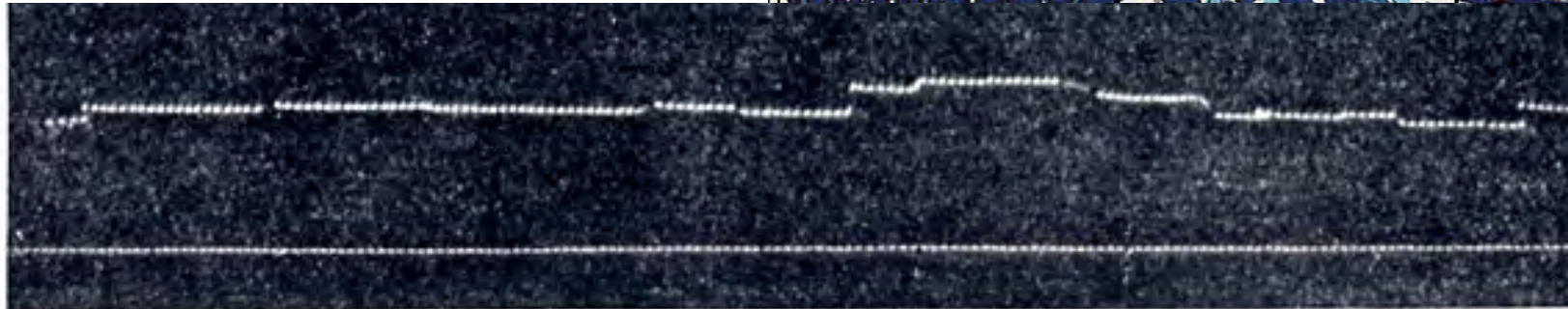


Huey (1898) *American Journal of Psychology*

Analysis Buswell, 1935



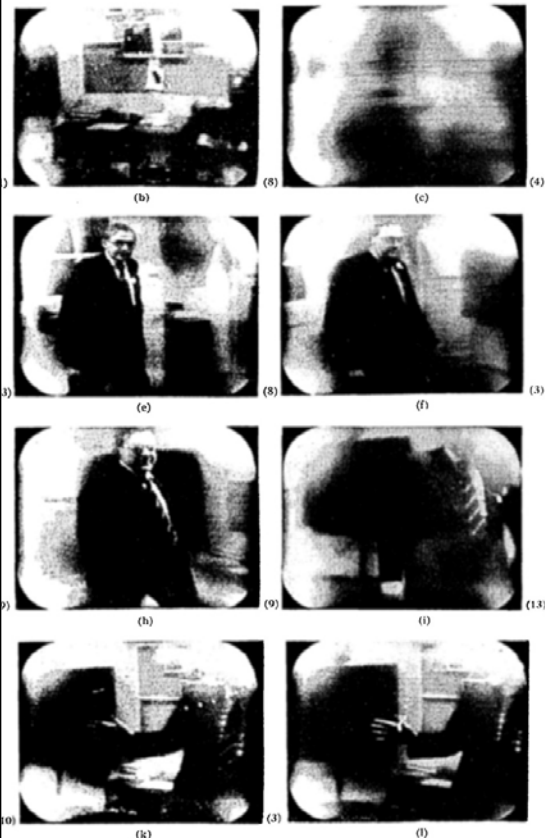
1. 6.1 2.5-9.2	2. 9.2 6.7-5.0	3. 2.4 1.7-0.8	4. 0.3 0-0
5. 5.8 1.7-2.5	6. 15.3 26.7-15.8	7. 5.0 5.8-7.5	8. 1.4 0.8-5.0
9. 5.6 2.5-2.5	10. 10.0 20.0-7.5	11. 13.4 10.0-14.2	12. 6.1 0-10.8
13. 1.5 1.7-5.0	14. 4.0 6.7-5.0	15. 11.8 10.8-5.8	16. 2.1 2.5-3.3



Data Analysis:



The main purpose and usefulness of this head camera technique is to give an immediate picture of on what the subject is fixating, whatever his body, head, and eye movements may be, without the need for analysis and computation to reconstruct his pattern of movements with respect to the scene before him. The film record can also be analyzed in detail in the usual way to study the relative movement of head, eyes, and scene; from examining the behavior of a few subjects and analyzing their performance in this way fruitful hypotheses may well result which can then be tested on a larger number of subjects with simpler experimental methods.



Shackel (1960) *JOSA*

Analyzing lab-based gaze data



Analyzing Video-based Gaze Data



What is the dominant natural physical process that has shaped this landscape, and what is the evidence for that process?

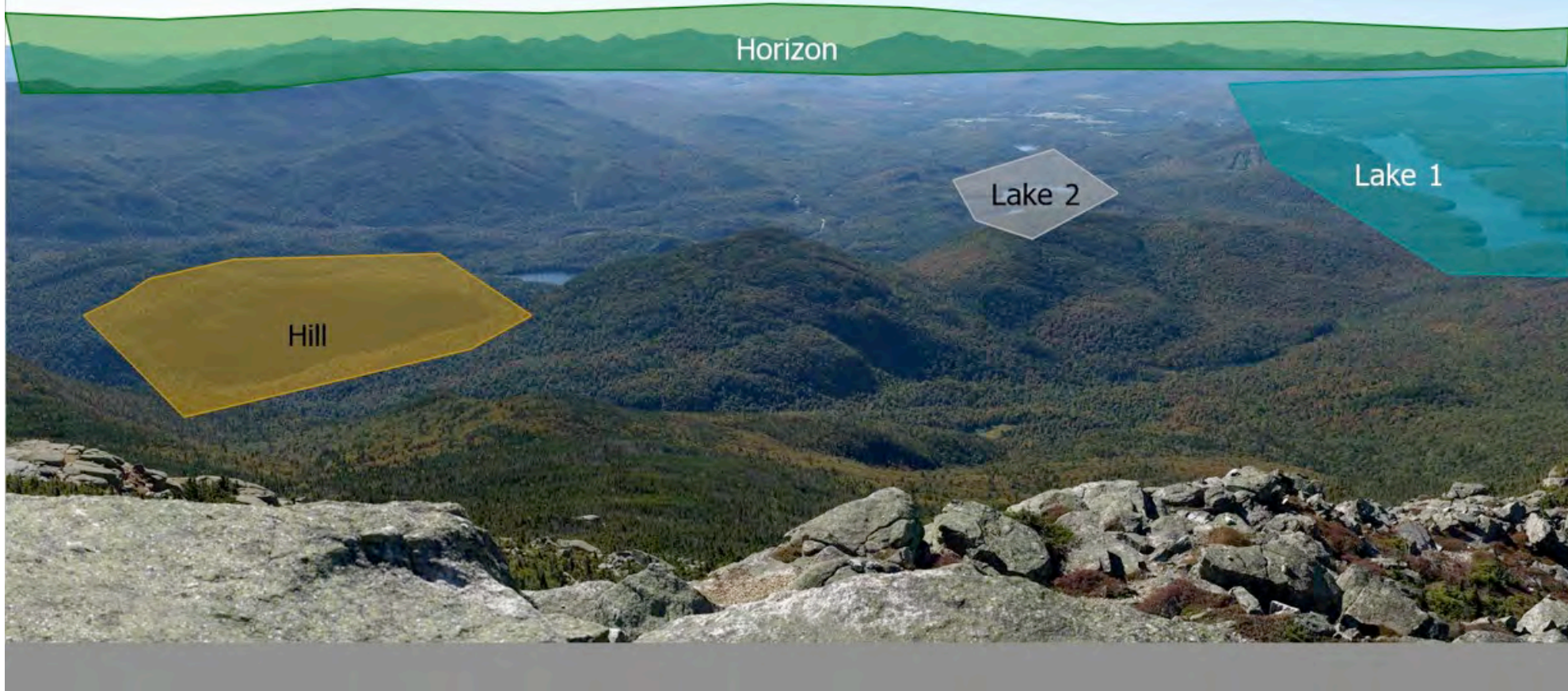


Analyzing Video-based Gaze Data

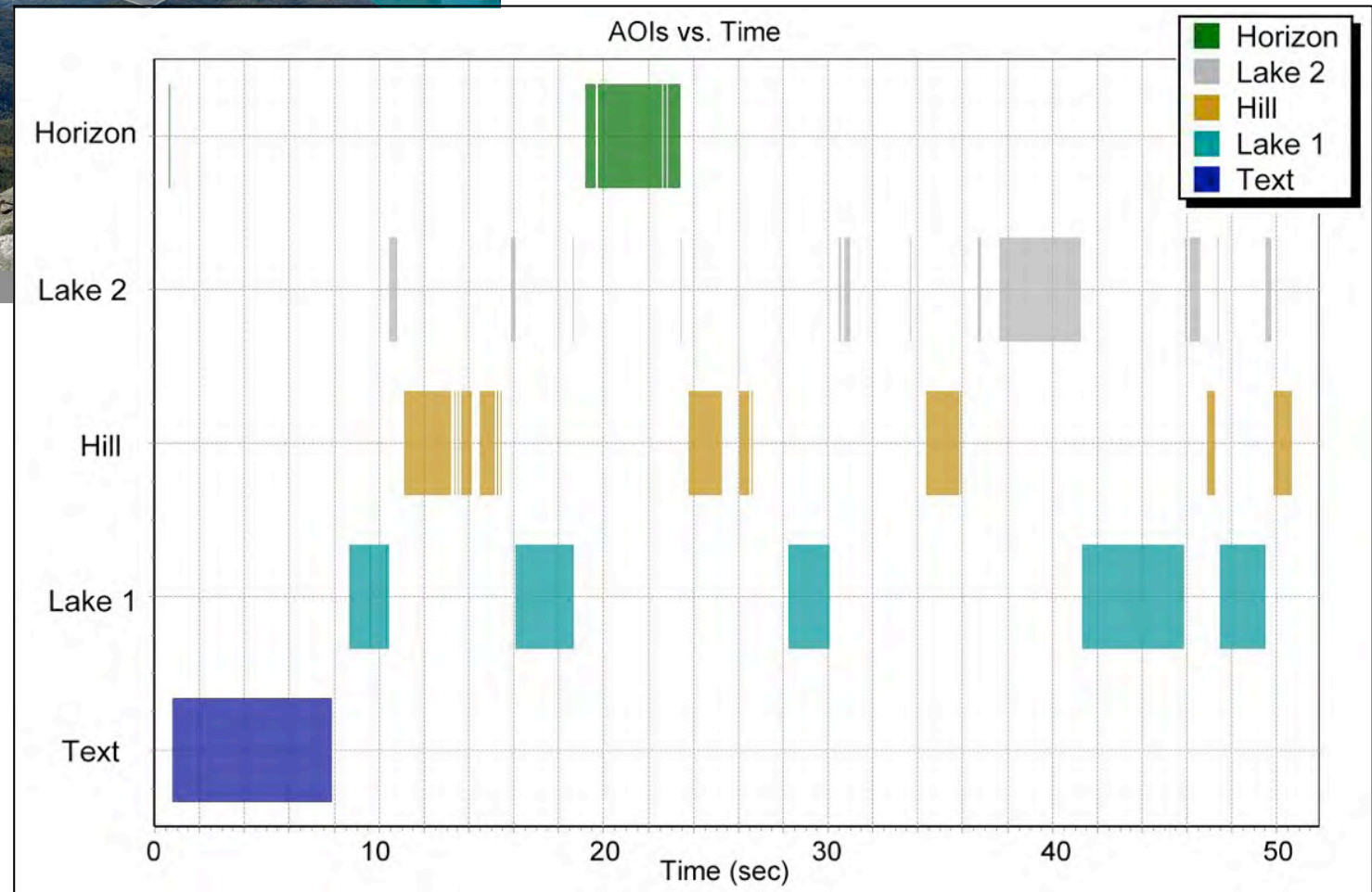
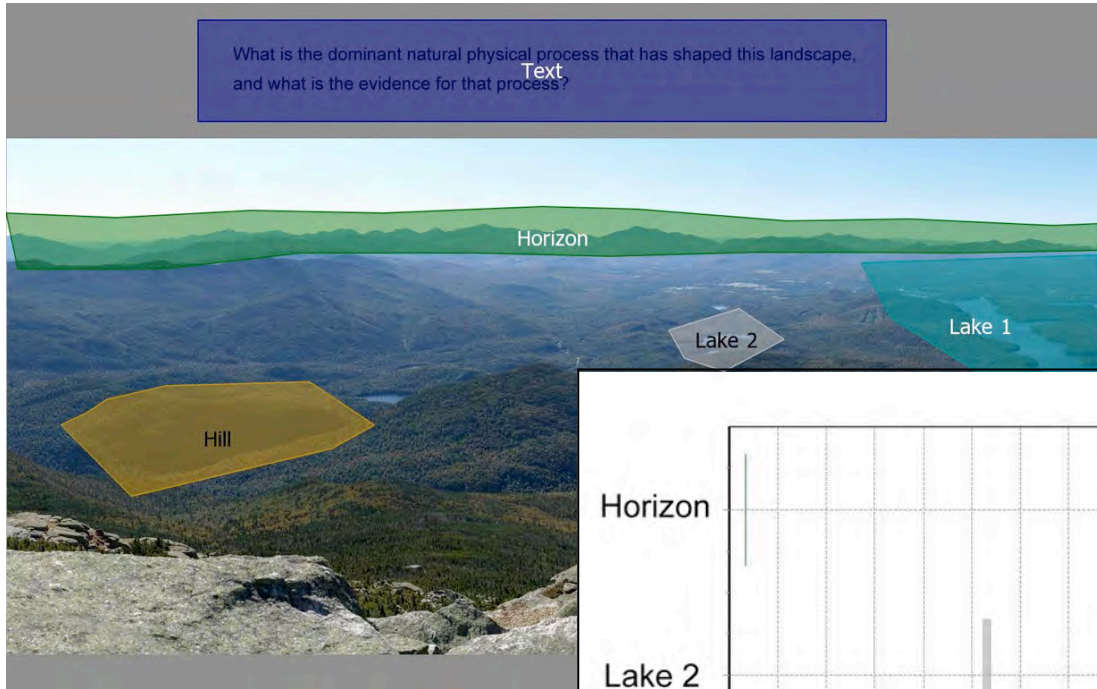


What is the dominant natural physical process that has shaped this landscape, and what is the evidence for that process?
Text

Define Areas of Interest (AOIs)



Analyzing Video-based Gaze Data



Analyzing Video-based Gaze Data



What is the dominant natural physical process that has shaped this landscape, and what is the evidence for that process?

Text

Sequence: 1
Entry time: 0.250
Dwell time: 8.187
Hit ratio: 1.00
Revisits: 0.45
Average fixation: 0.243
First fixation: 0.285
Fixation count: 23.66

Sequence: 2
Entry time: 0.250
Dwell time: 4.634
Hit ratio: 1.00
Revisits: 2.63
Average fixation: 0.217
First fixation: 0.385
Fixation count: 14.76

Horizon

Lake 2

Lake 1

Hill

Sequence: 5
Entry time: 11.845
Dwell time: 5.488
Hit ratio: 0.50
Revisits: 0.87
Average fixation: 0.408
First fixation: .505
Fixation count: 12.84

Sequence: 4
Entry time: 10.650
Dwell time: 6.104
Hit ratio: 0.66
Revisits: 0.83
Average fixation: 0.608
First fixation: .505
Fixation count: 10.87

Sequence: 3
Entry time: 8.437
Dwell time: 14.323
Hit ratio: 1.00
Revisits: 4.63
Average fixation: 0.414
First fixation: .265
Fixation count: 9.12



NTID_03_E1_05

0:00:00.00/600

begin end

scan back back 00:00:00:00 next scan fwd

Subject: 05 Experiment: NSF_E1
Initials: Tape: NTID_03_E1_05
Trial: 01_A0_01 Coder: MEA

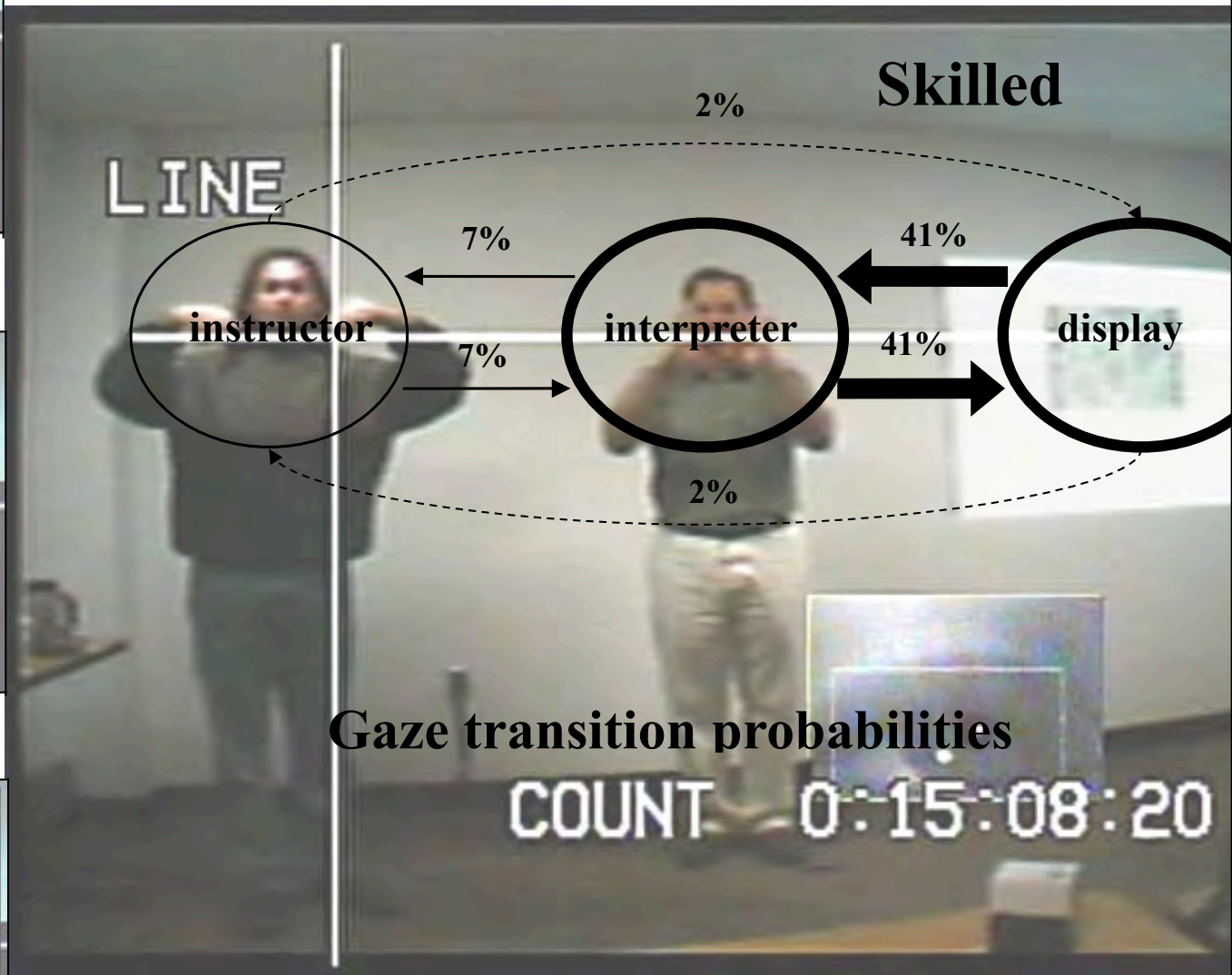
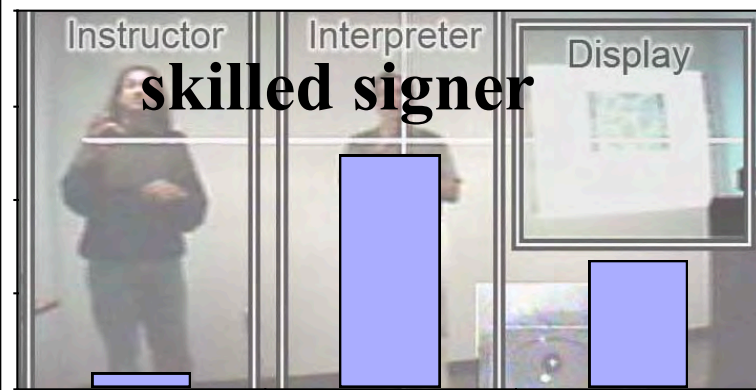
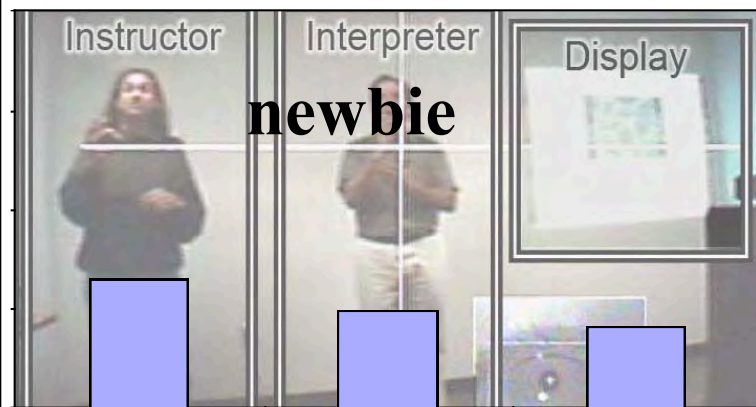
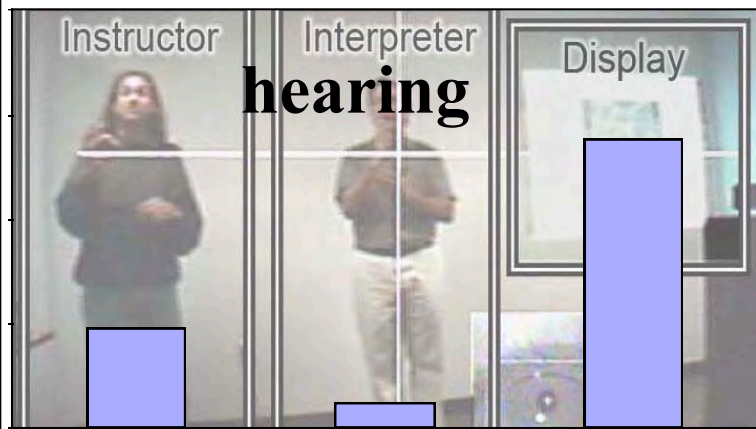
Observation Playback Settings 0 Note Log

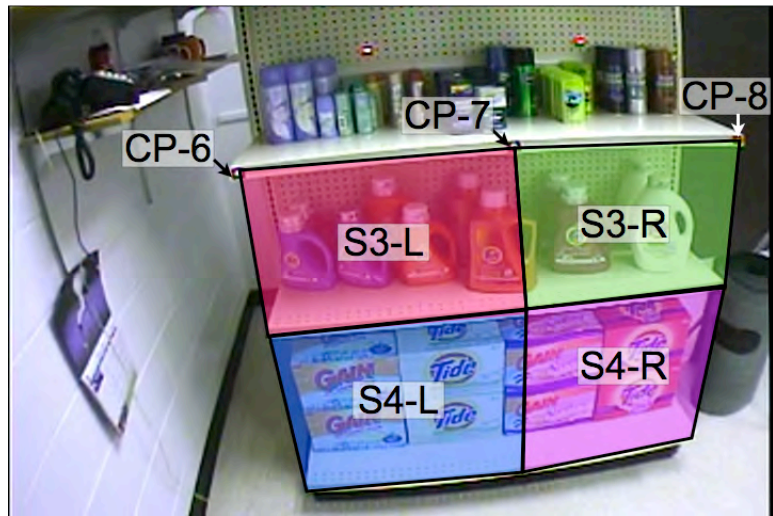
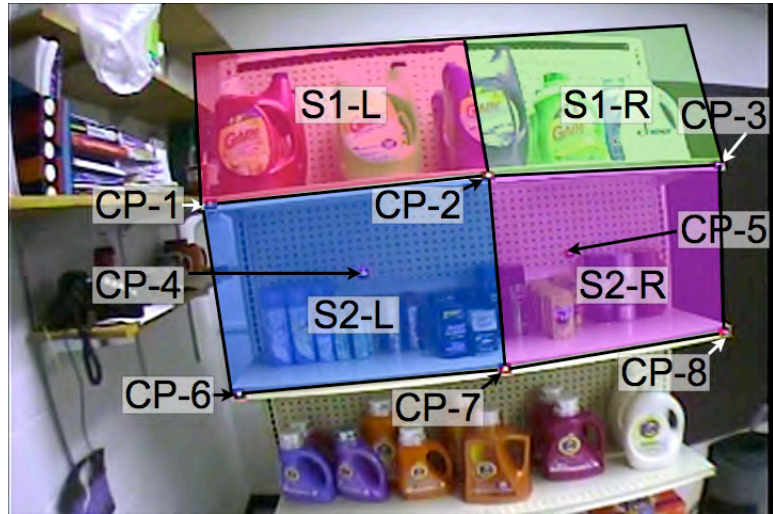
- Restore Keyboard
- 0 Enter text in "0 Note" below...
 - F1 Instructor
 - F2 Interpreter
 - F3 Display
 - F4 Track Loss
 - F5 Look Away
 - F6
 - F7
 - F8
 - F9

Microsoft Excel - NSF_E1-05-1-jbp.xls

count	timecode	msec	function key definition
1	00:05:50:25	0	Interpreter
2	00:06:13:00	22167	Instructor
3	00:06:15:12	24567	Interpreter
4	00:06:18:06	27367	Instructor
5	00:06:18:23	27933	Interpreter
6	00:06:38:01	47200	Display
7	00:06:41:01	50200	Interpreter
8	00:07:05:23	74933	Display
9	00:07:13:15	82667	Interpreter
10	00:07:17:10	86500	Display
11	00:07:17:24	86967	Instructor
12	00:07:19:15	88667	Interpreter
13	00:07:26:22	95900	Instructor
14	00:07:27:07	96400	Interpreter
15	00:07:39:01	108200	Instructor
16	00:07:39:22	108900	Interpreter
17	00:07:47:04	116300	Display
18	00:07:47:10	116500	Interpreter
19	00:07:48:12	117567	Instructor
20	00:07:49:10	118500	Interpreter
21	00:08:02:12	131567	Look_away
22	00:08:03:00	132167	Interpreter
23	00:08:03:09	132467	Instructor

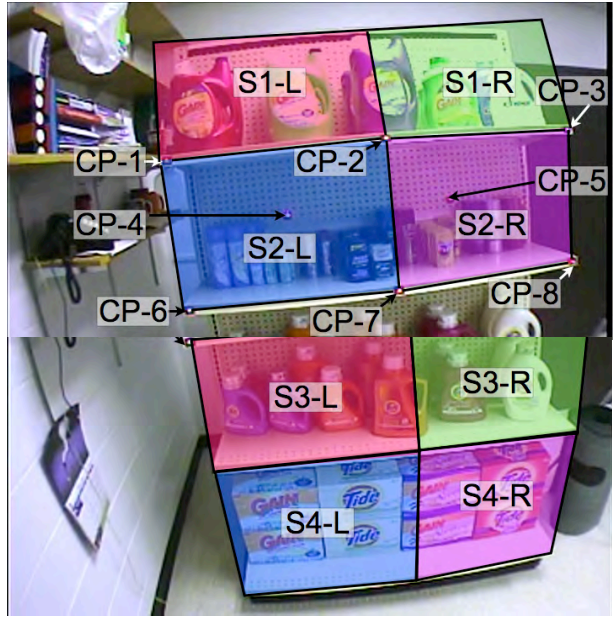
RITCode



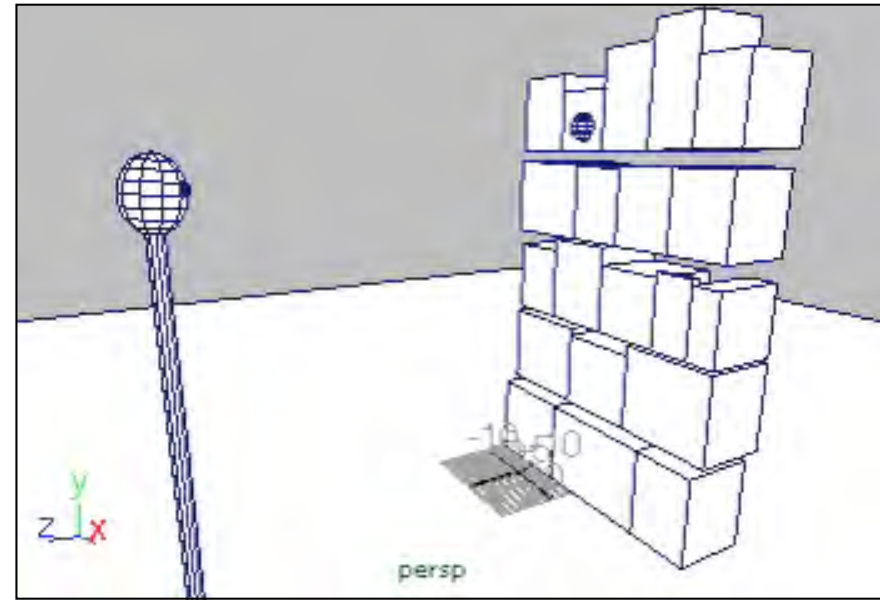




Subject 1
PG 1/09/09



Susan Munn: FixTracer



2D POR

3D model

Susan Munn
RIT PhD,
now at ASL

Support: P&G

Object ID

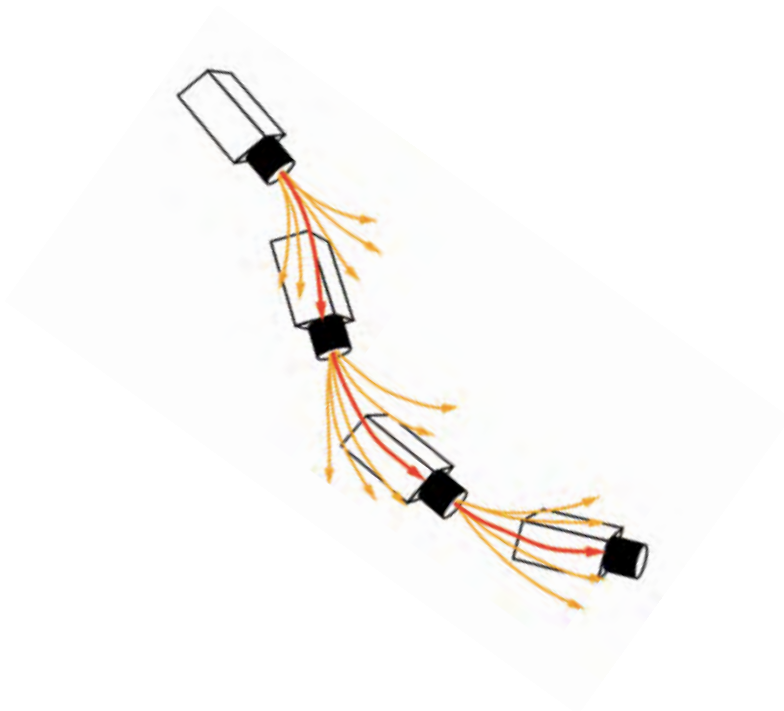


Subject 2
2-27-09

SLAM

MonoSLAM: Davison et al., *IEEE Trans PAMI* 2007

Visual SLAM: Takemura et al., *ETRA* 2010



Object recognition



Figure 2. Object recognition illustration in shopping setting

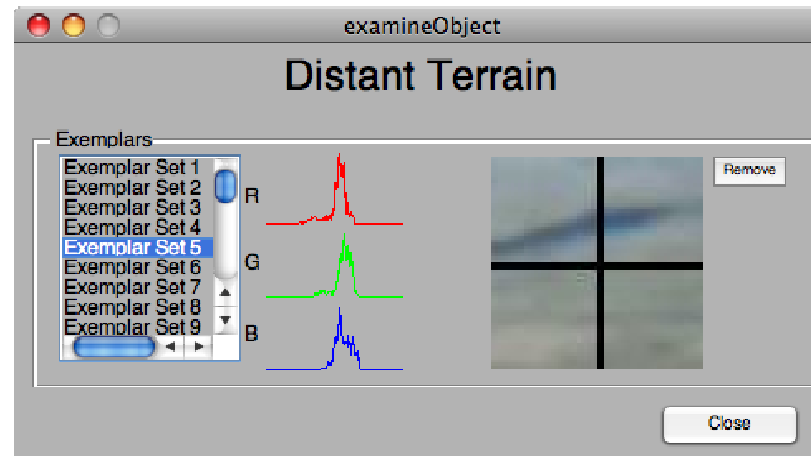
Brône, Oben, & Goedemé, PETMEI 2011



SemantiCode



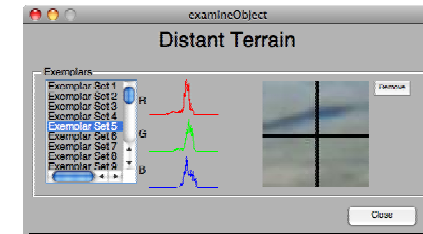
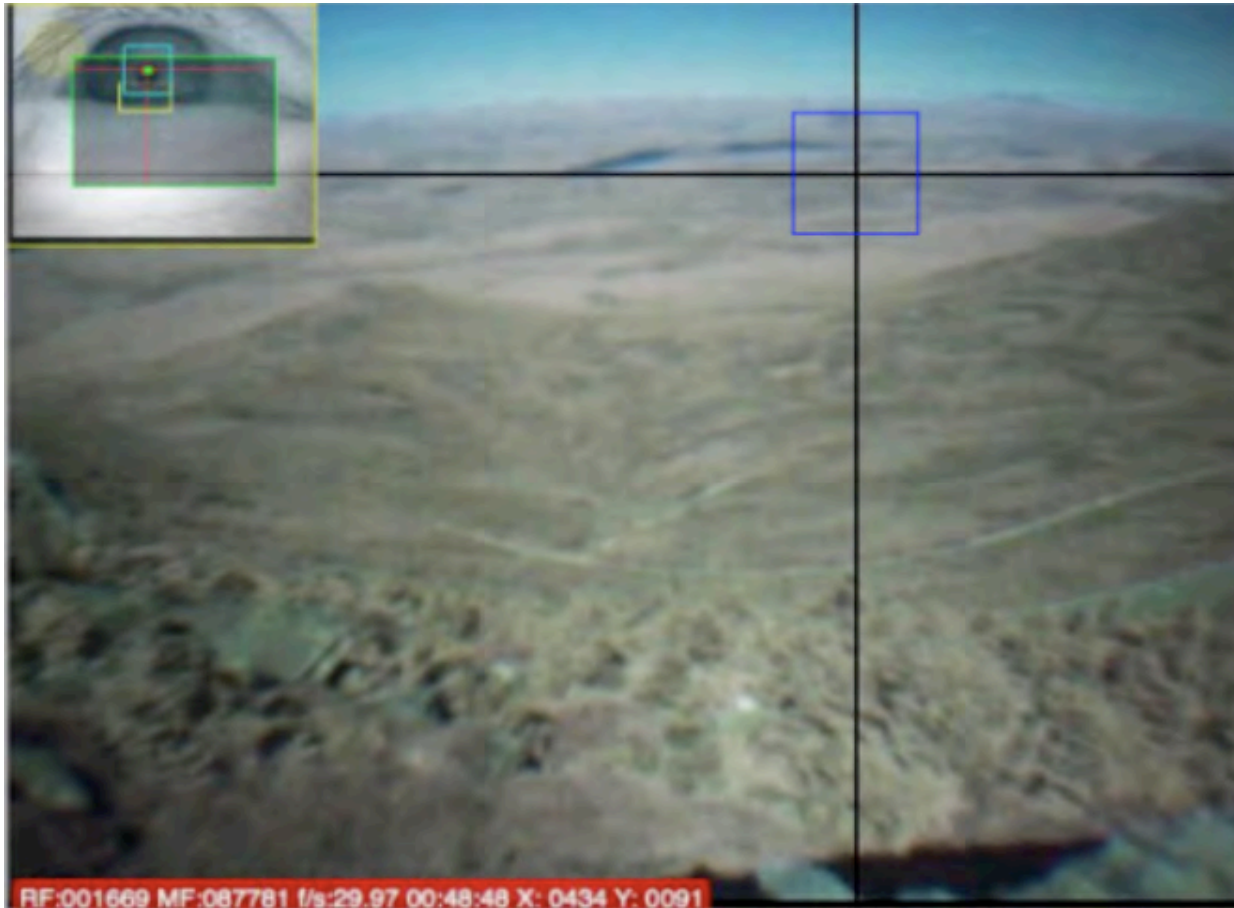
SemantiCode

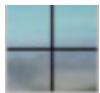


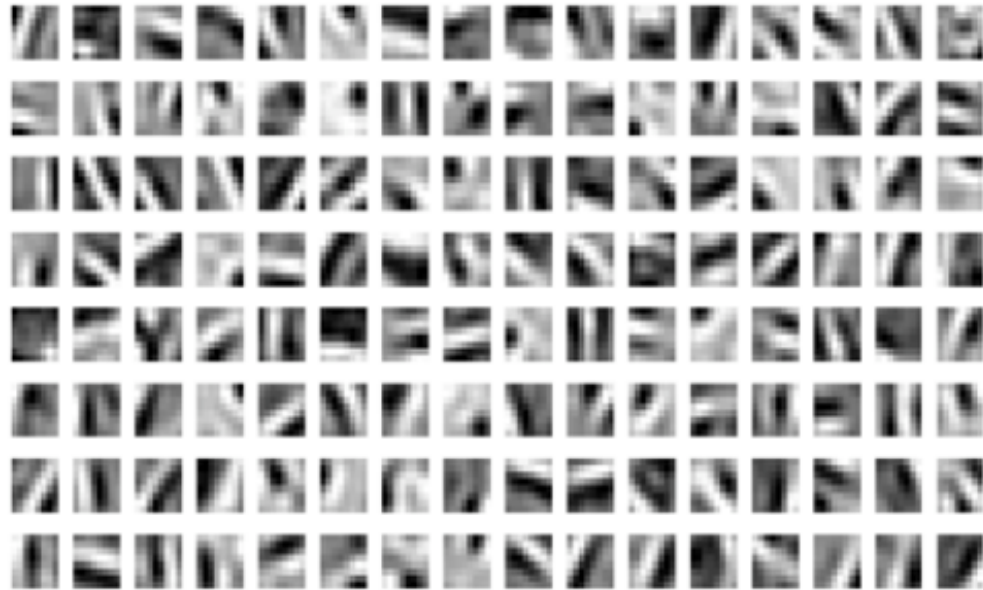
Fixations can be ‘tagged’
as class exemplars

Color histogram intersections
(Swain & Ballard, '90)

Using only RGB color histograms:



	Midground	Lighter terrain	Distant terrain	 Horizon	Lake
Midground terrain	81%	52%	26%	38%	55%
Lighter terrain	34%	77%	72%	54%	65%
Distant terrain	45%	65%	82%	58%	71%
Horizon	14%	30%	39%	60%	55%
Lake	14%	61%	72%	65%	81%



Other features (spectral, spatial, temporal)
can be used to identify exemplars.

SemantiCode

The screenshot displays the SemantiCode application window. The main video frame shows a person in a blue jacket standing on a rocky path. An inset in the top-left corner shows a zoomed-in view of the person's face with a red bounding box and a green crosshair. The interface includes several control elements:

- Buttons:** "Load Video", "Save Results", "Add Object", "Delete", "Tag", "Previous", "Next", "Add", "Manage", "Import", "Export", "Delete".
- Object List:** A list box for tracking objects, currently empty.
- Library List:** A list box containing ".DS" entries, with associated "Add", "Manage", "Import", "Export", and "Delete" buttons.
- Object Name Input:** A grid of 10 input fields (0-9) for naming objects, each with a "00.0%" progress indicator.
- Table:** A table with columns "Fixation Number" and "Semantic Tag", currently empty.
- Navigation:** "Previous" and "Next" buttons, a "Frame:" dropdown set to "3", and a "Video:" dropdown set to "S9-D5-Clip-3".
- Status:** "Untagged" label and "Debugging Text" area at the bottom.

Debugging Text
/Files from Ernest Jr./Research/Procter_Gamble/ObjectiveC CacheGuie/SemantiCode_v0_8/Dat


SemantiCode

The screenshot displays the SemantiCode software interface. The main window, titled "Window", shows a video frame of a person in a blue jacket. An inset window in the top-left corner shows a zoomed-in view of the person's face with a red bounding box. A modal dialog box titled "Add New Object" is open in the center, with the "Object Name" field containing the text "Professor". The dialog has "Add" and "Cancel" buttons. To the right of the main window, there is an "Object List" panel with "Add Object" and "Delete" buttons, and a "Tag" button. Below the "Object List" is a table with columns "Fixation Number" and "Semantic Tag". To the right of the "Object List" is a "Library List" panel with "Add", "Manage", "Import", "Export", and "Delete" buttons. Below the "Library List" is a grid of 10 object slots, each with a number (0-9) and a "00.0%" progress indicator. At the bottom of the main window, there are "Previous" and "Next" buttons, a "Frame: 3" dropdown, and a "Video: S9-D5-Clip-3" dropdown. The text "Untagged" is displayed below these controls. At the bottom left, there is a "Debugging Text" field containing the path: "/Files from Ernest Jr./Research/Procter_Gamble/ObjectiveC CacheGuie/SemantiCode_v0_8/Dat".

SemantiCode

Window

Load Video Save Results



Object List


Professor

Add Object Delete Tag

Library List

.DS	Add
.DS	Manage
	Import
	Export
	Delete

Professor

0			
	26.40%	00.0%	00.0%
7		8	9
	Object Name		
	00.0%		
4		5	6
	Object Name		
	00.0%		
1		2	3
	Object Name		
	00.0%		

Fixation Number Semantic Tag

3	Professor
---	-----------

Previous Next Frame: 4 Video: S9-D5-Clip-3


Professor?

Debugging Text
/Files from Ernest Jr./Research/Procter_Gamble/ObjectiveC CacheGuie/SemantiCode_v0_8/Dat

SemantiCode

Window

Load Video Save Results



Object List

Professor

Add Object Delete Tag

Library List

.DS	.DS
-----	-----

Add Manage Import Export Delete

Professor

0	26.40%	00.0%	00.0%		
7	00.0%	8	00.0%	9	00.0%
4	00.0%	5	00.0%	6	00.0%
1	00.0%	2	00.0%	3	00.0%

Fixation Number Semantic Tag

3	Professor
---	-----------

Previous Next Frame: 4 Video: S9-D5-Clip-3

Professor?

Debugging Text
/Files from Ernest Jr./Research/Procter_Gamble/ObjectiveC CacheGuie/SemantiCode_v0_8/Dat

SemantiCode

The screenshot displays the SemantiCode application interface. At the top, there are 'Load Video' and 'Save Results' buttons. The main area features a video player with a small inset showing a zoomed-in view of a person. A 'Window' dialog is open, titled 'Add New Object', with the text 'Object Name: Foreground pi' and 'Add' and 'Cancel' buttons. To the right, the 'Object List' shows 'Professor' and 'Foreground pine'. Below it is a table with 'Fixation Number' and 'Semantic Tag' columns, containing entries for 'Professor' and 'Foreground pine'. The 'Library List' on the right contains two '.DS' entries and a grid of object slots, some with small images and percentage values like '44.40%' and '25.30%'. At the bottom, there are 'Previous' and 'Next' buttons, 'Frame: 5' and 'Video: S9-D5-Clip-3' dropdowns, and a red text prompt 'Professor?'. A debugging text path is visible at the bottom left.

Window

Load Video Save Results

Window

Add New Object

Object Name: Foreground pi

Add Cancel

Object List

Professor

Foreground pine

Add Object Delete Tag

Library List

Add Manage Import Export Delete

Professor

0 44.40% 00.0% 00.0%

7 25.30% 8 00.0% 9 00.0%

Foreground pine 25.30% Object Name 00.0% Object Name 00.0%

4 00.0% 5 00.0% 6 00.0%

Object Name 00.0% Object Name 00.0% Object Name 00.0%

1 00.0% 2 00.0% 3 00.0%

Object Name 00.0% Object Name 00.0% Object Name 00.0%

Fixation Number	Semantic Tag
3	Professor
4	Foreground pine

Previous Next Frame: 5 Video: S9-D5-Clip-3

Professor?

Debugging Text
/Files from Ernest Jr./Research/Procter_Gamble/ObjectiveC CacheGuie/SemantiCode_v0_8/Dat

SemantiCode

The screenshot displays the SemantiCode application interface. On the left, a video player shows a scene with people and a tripod. A small inset shows a zoomed-in view of a person's face. Below the video player are navigation buttons: "Previous", "Next", "Frame: 7", and "Video: S9-D5-Clip-3". A red text prompt "Professor?" is visible below the video. At the bottom left, there is a "Debugging Text" field containing the path: "/Files from Ernest Jr./Research/Procter_Gamble/ObjectiveC CacheGuie/SemantiCode_v0_8/Dat".

On the right side, there are two main panels: "Object List" and "Library List".

Object List:

- Professor
- Foreground pine
- Tripod
- Hat

Buttons: "Add Object", "Delete", "Tag".

Library List:

- .DS
- .DS

Buttons: "Add", "Manage", "Import", "Export", "Delete".

Below the Library List, there is a grid of object thumbnails with their names and confidence percentages:

Fixation Number	Object Name	Confidence
0	Professor	48.90%
7	Hat	34.35%
8	Tripod	32.25%
9	Foreground pine	13.30%
4	Object Name	00.0%
5	Object Name	00.0%
6	Object Name	00.0%
1	Object Name	00.0%
2	Object Name	00.0%
3	Object Name	00.0%

Below the Library List, there is a table of fixation numbers and semantic tags:

Fixation Number	Semantic Tag
3	Professor
4	Foreground pine
5	Tripod
6	Hat



SemantiCode

The screenshot displays the SemantiCode software interface. On the left, a video player shows a scene with people and a tripod. An inset window shows a zoomed-in view of a specific object. Below the video player are navigation buttons for 'Previous' and 'Next', and fields for 'Frame: 8' and 'Video: S9-D5-Clip-3'. A red text prompt 'Foreground pine?' is visible below the video player. On the right side, there are two main panels: 'Object List' and 'Library List'. The 'Object List' contains a list of objects: Professor, Foreground pine, Tripod, and Hat, with 'Hat' selected. Below this list are 'Add Object' and 'Delete' buttons, and a 'Tag' button. The 'Library List' shows a grid of object thumbnails with their respective names and confidence percentages. The 'Foreground pine' section shows a thumbnail with a 45.85% confidence. Other thumbnails include 'Professor' (21.90%), 'Tripod' (19.20%), and 'Hat' (5.20%). Below the 'Library List' is a table with 'Fixation Number' and 'Semantic Tag' columns.

Fixation Number	Semantic Tag
3	Professor
4	Foreground pine
5	Tripod
6	Hat
7	Professor

SemantiCode

The screenshot displays the SemantiCode software interface. On the left, a video player shows a scene with people and a tripod. A 'Load Video' button is at the top left, and a 'Save Results' button is at the top right. Below the video player are 'Previous' and 'Next' navigation buttons, a 'Frame: 9' dropdown, and a 'Video: S9-D5-Clip-3' dropdown. A red text prompt 'Professor?' is visible below the video player. At the bottom left, there is a 'Debugging Text' section with the path: /Files from Ernest Jr./Research/Procter_Gamble/ObjectiveC CacheGuie/SemantiCode_v0_8/Dat

On the right side, there are two main panels: 'Object List' and 'Library List'. The 'Object List' contains a list of objects: Professor, Foreground pine, Tripod, and Hat. The 'Hat' object is currently selected. Below this list are 'Add Object' and 'Delete' buttons, and a 'Tag' button. The 'Library List' shows a grid of object thumbnails with their names and percentages. The 'Professor' object is highlighted in the library list.

Fixation Number	Semantic Tag
3	Professor
4	Foreground pine
5	Tripod
6	Hat
7	Professor
8	Foreground pine

Object Name	Percentage
Professor	60.25%
Professor	43.75%
Hat	31.10%
Tripod	29.20%
Foreground pine	12.95%
Object Name	00.0%
Object Name	00.0%
Object Name	00.0%
Object Name	00.0%
Object Name	00.0%
Object Name	00.0%

SemantiCode

The screenshot displays the SemantiCode application window. The main video frame shows a scene with several people and a tripod. A smaller inset window in the top-left corner provides a magnified view of a specific area in the video. The interface includes a 'Load Video' button and a 'Save Results' button. On the right side, there are two lists: 'Object List' and 'Library List'. The 'Object List' contains 'Professor', 'Foreground pine', 'Tripod', and 'Hat', with 'Hat' currently selected. The 'Library List' shows two '.DS' entries and buttons for 'Add', 'Manage', 'Import', 'Export', and 'Delete'. Below these lists, there are buttons for 'Add Object' and 'Delete', and a 'Tag' button. A table at the bottom right shows the results of the analysis, with columns for 'Fixation Number' and 'Semantic Tag'. The table data is as follows:

Fixation Number	Semantic Tag
5	tripod
6	Hat
7	Professor
8	Foreground pine
9	Professor
10	Professor
11	Professor
12	Professor
13	Professor

Below the table, there are buttons for 'Previous' and 'Next', and a 'Frame' dropdown set to '14' and a 'Video' dropdown set to 'S9-D5-Clip-3'. A small thumbnail of the video frame is shown to the left of these controls. Below the thumbnail, the text 'Tripod?' is displayed in red. At the bottom left, there is a 'Debugging Text' section with the path: '/Files from Ernest Jr./Research/Procter_Gamble/ObjectiveC CacheGuie/SemantiCode_v0_8/Dat'.

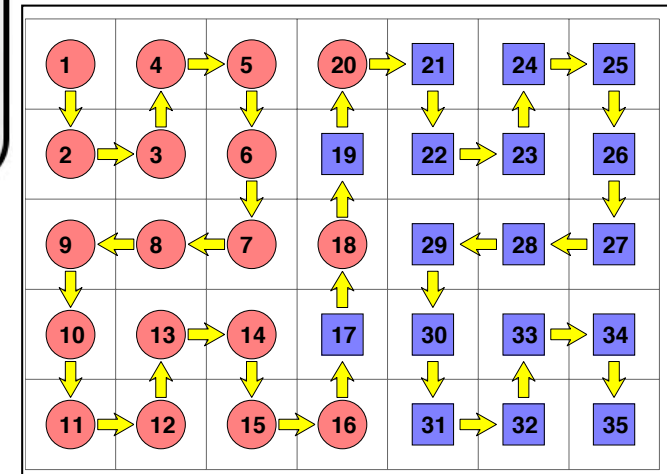
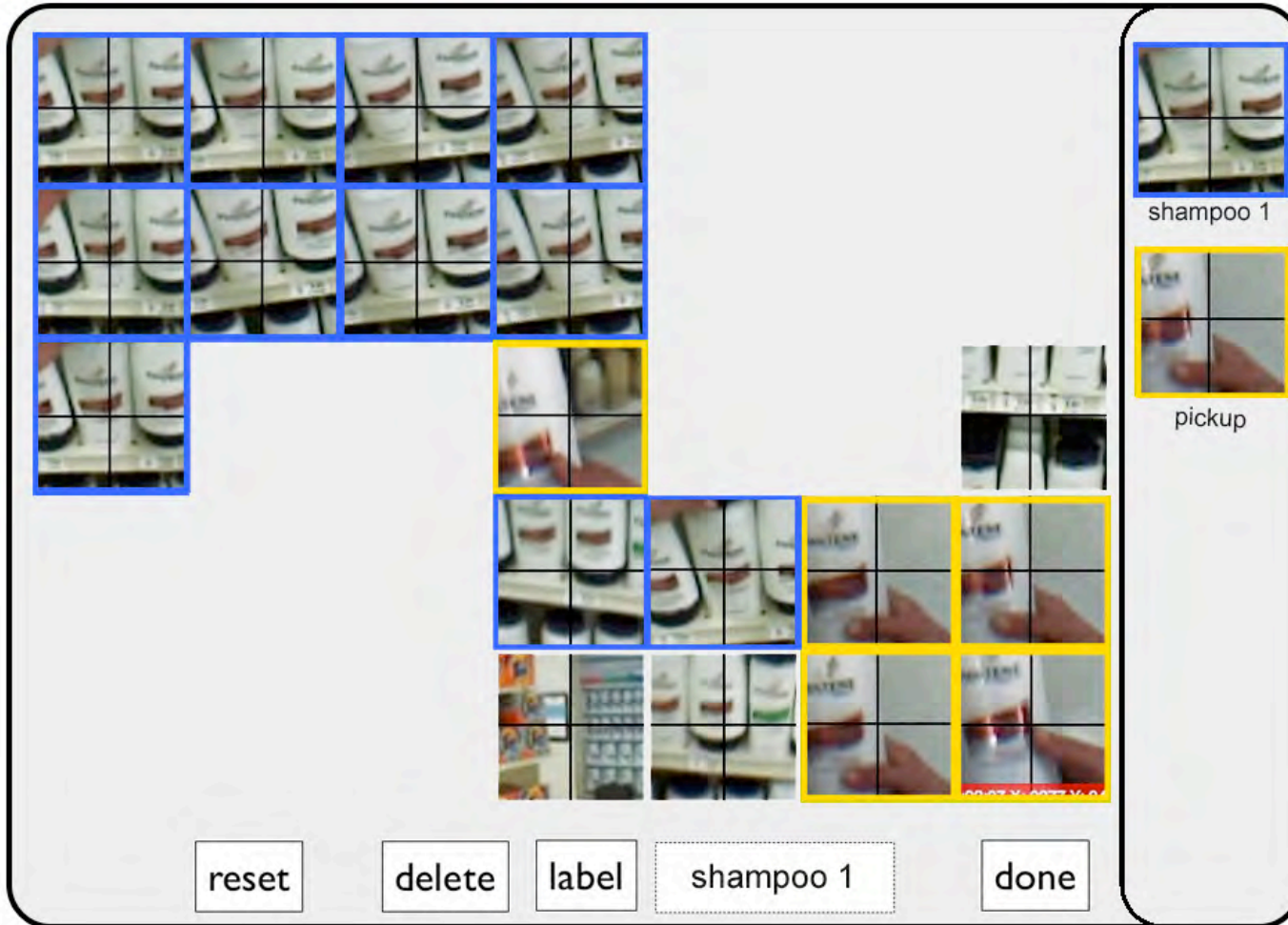
SemantiCode

The screenshot displays the SemantiCode application window. The main area shows a video frame of a mountain landscape. A small inset in the top-left corner shows a zoomed-in view of a person's face with a red bounding box. The interface includes several panels and controls:

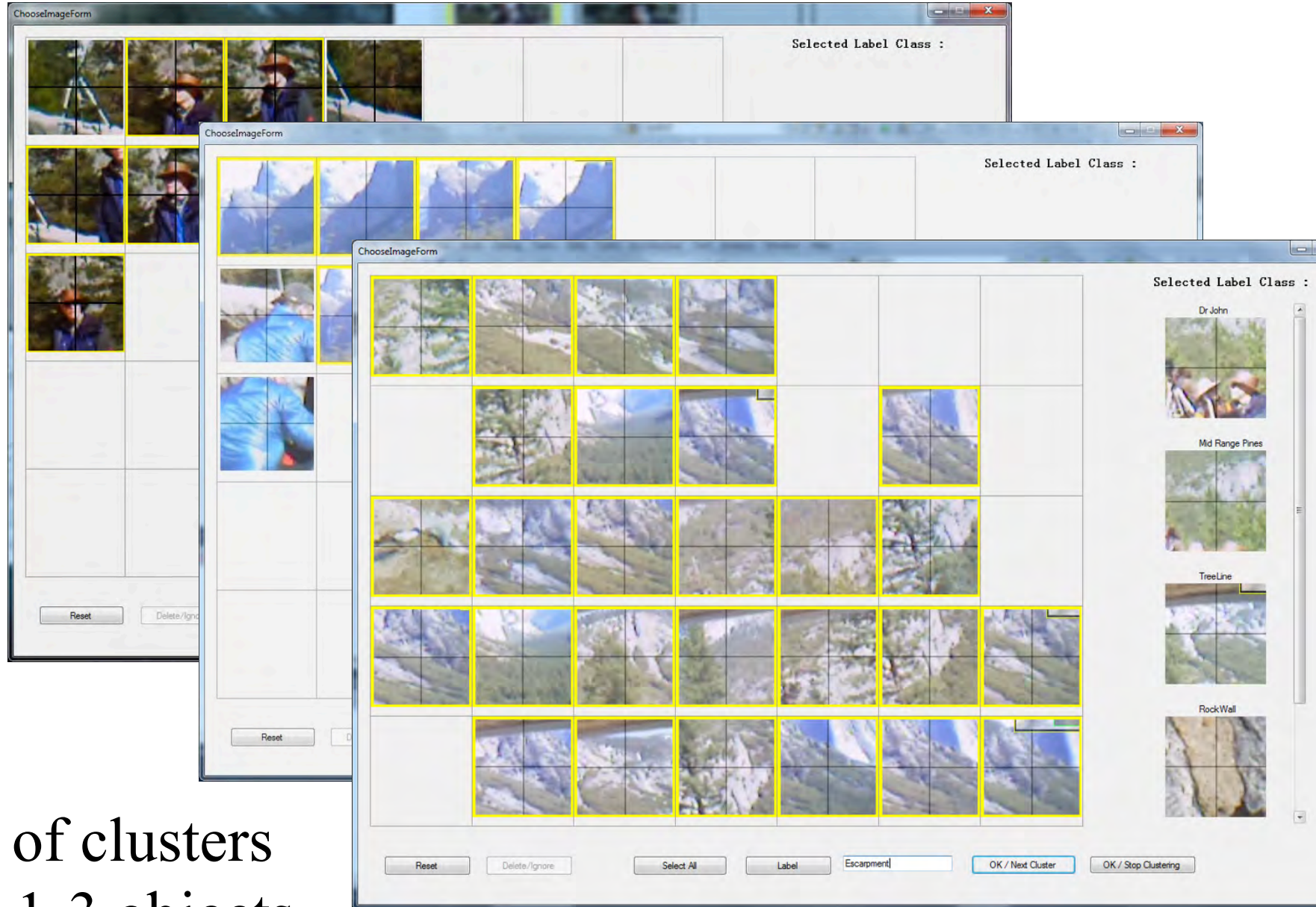
- Top Left:** "Load Video" button.
- Top Right:** "Save Results" button.
- Object List:** A list of detected objects: Professor, Foreground pine, Tripod, Hat, Student 2. "Student 2" is currently selected.
- Library List:** A list of object classes: .DS, .DS. Buttons for "Add", "Manage", "Import", "Export", and "Delete" are present.
- Object Grid:** A grid of object thumbnails with their respective confidence scores:
 - 0: Professor (11.35%, 10.30%, 10.25%)
 - 7: Foreground pine (9.15%)
 - 8: Hat (6.95%)
 - 9: Tripod (6.30%)
 - 4: Student 2 (3.95%)
 - 5: Object Name (00.0%)
 - 6: Object Name (00.0%)
 - 1: Object Name (00.0%)
 - 2: Object Name (00.0%)
 - 3: Object Name (00.0%)
- Table:** A table showing fixation numbers and semantic tags for each frame:

Fixation Number	Semantic Tag
9	Professor
10	Professor
11	Professor
12	Professor
13	Professor
14	Student 2
15	Foreground pine
16	Professor
18	Foreground pine
- Bottom Left:** "Previous" and "Next" buttons, "Frame: 19" dropdown, and "Video: S9-D5-Clip-3" dropdown.
- Bottom Center:** A red text prompt: "Professor?"
- Bottom Left:** "Debugging Text" section with the path: "/Files from Ernest Jr./Research/Procter_Gamble/ObjectiveC CacheGuie/SemantiCode_v0_8/Dat".

SemantiCode

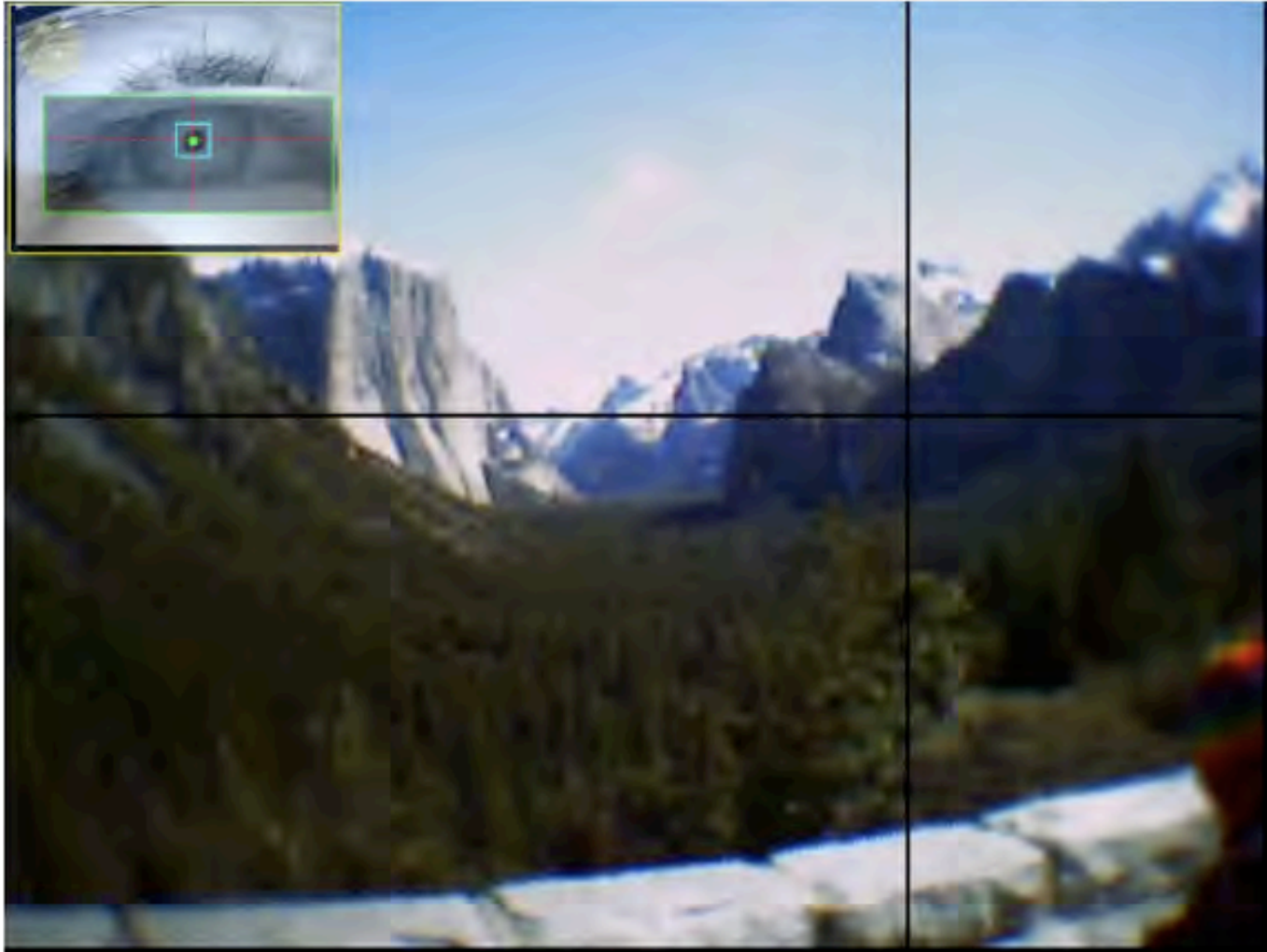


Analyzing Video-based Gaze Data

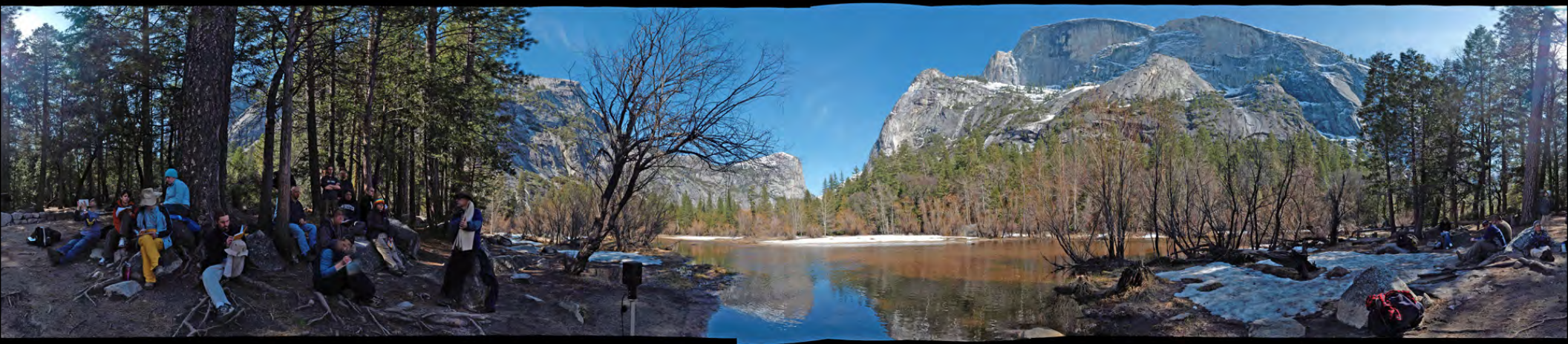


50% of clusters
have 1-3 objects

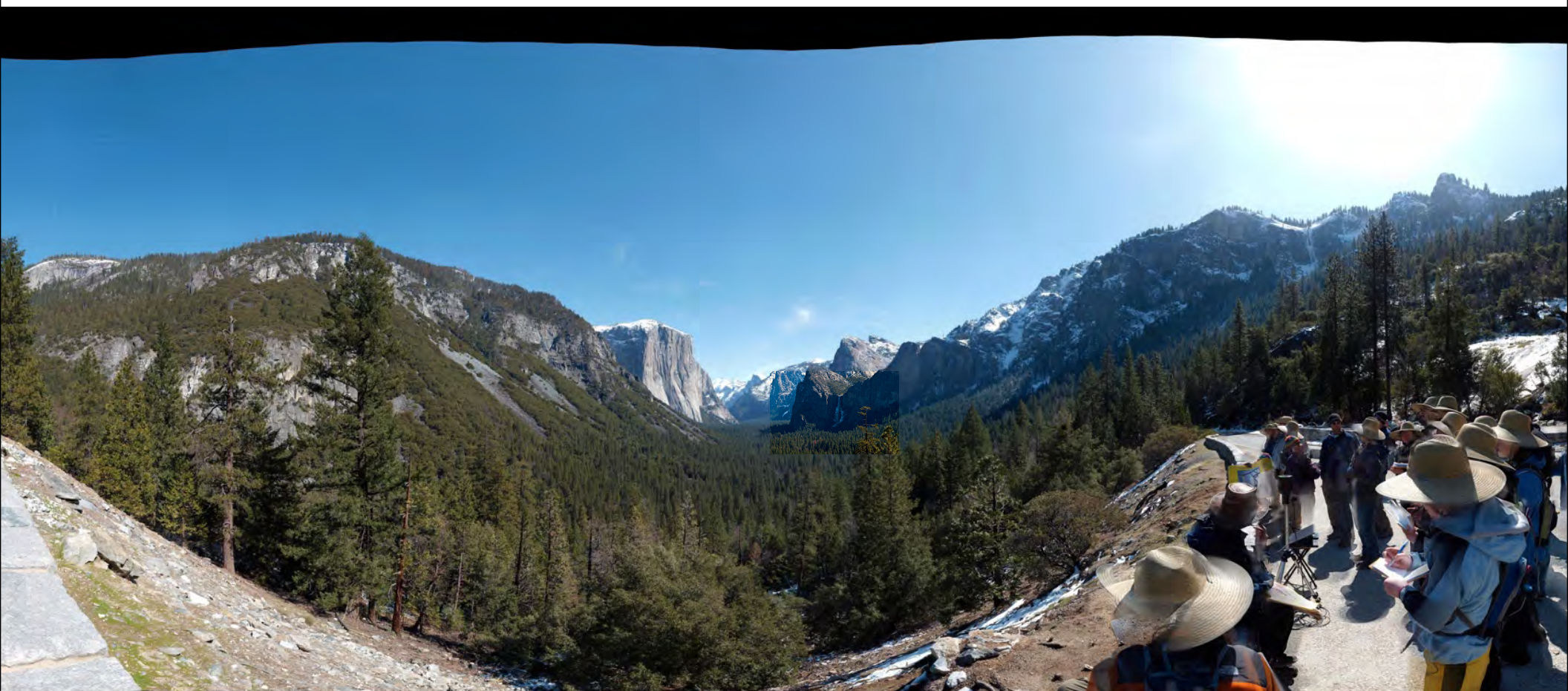
Limited resolution of scene video



Panoramic image capture

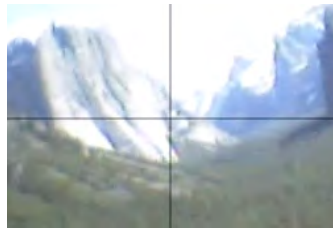


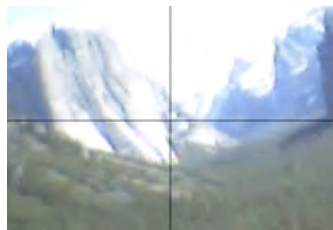
Panoramic image capture

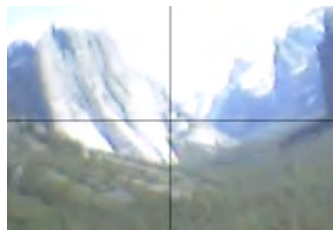


Panoramic image capture



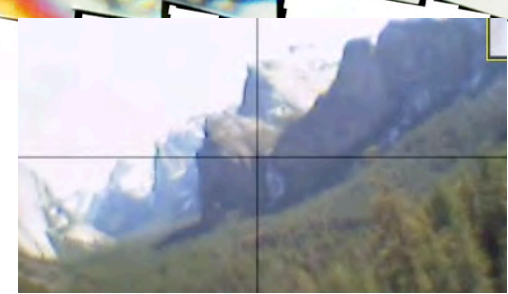
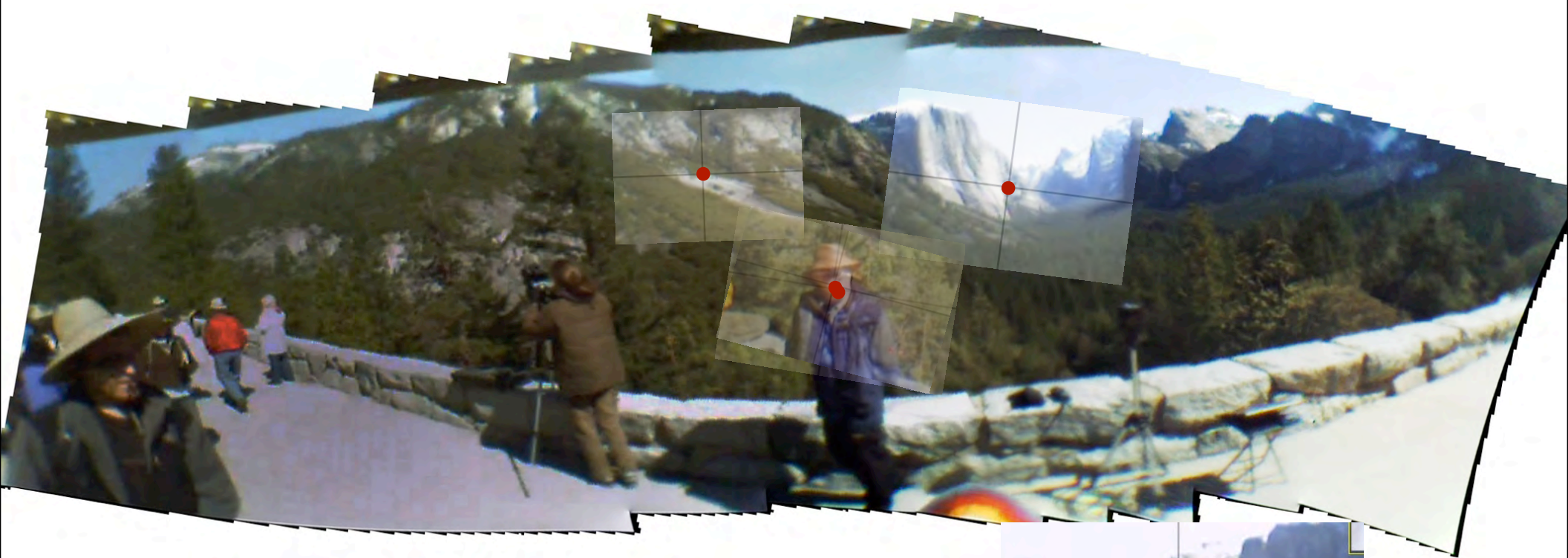


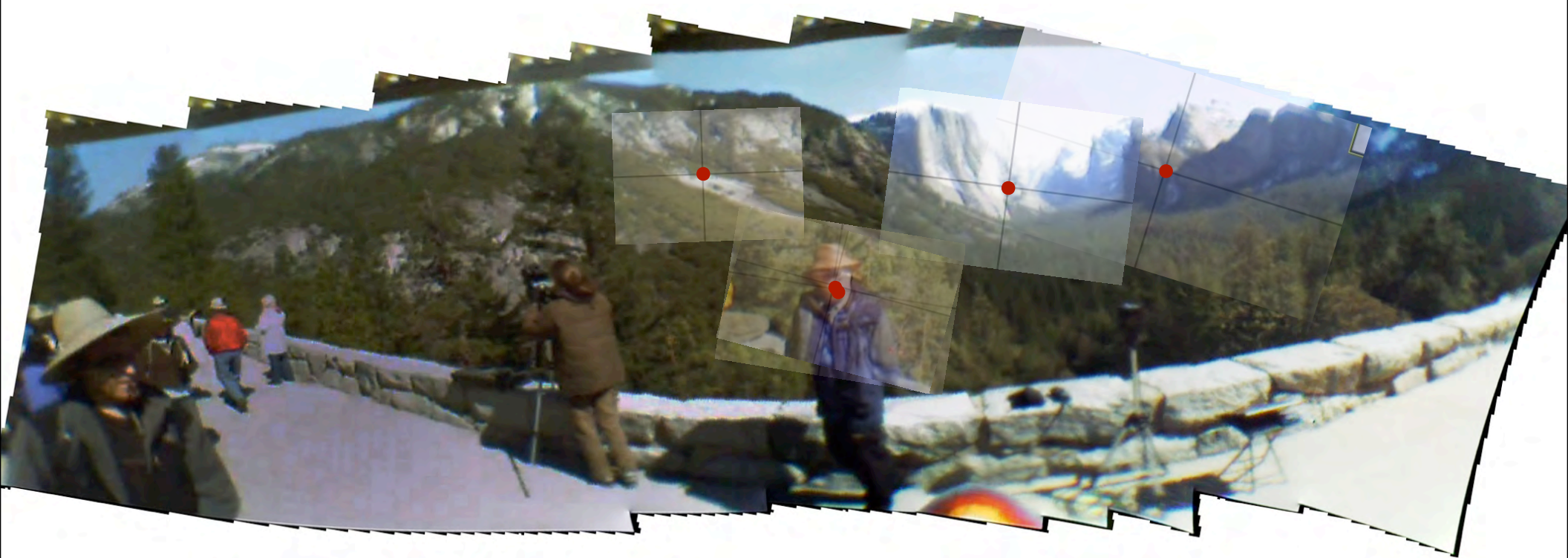






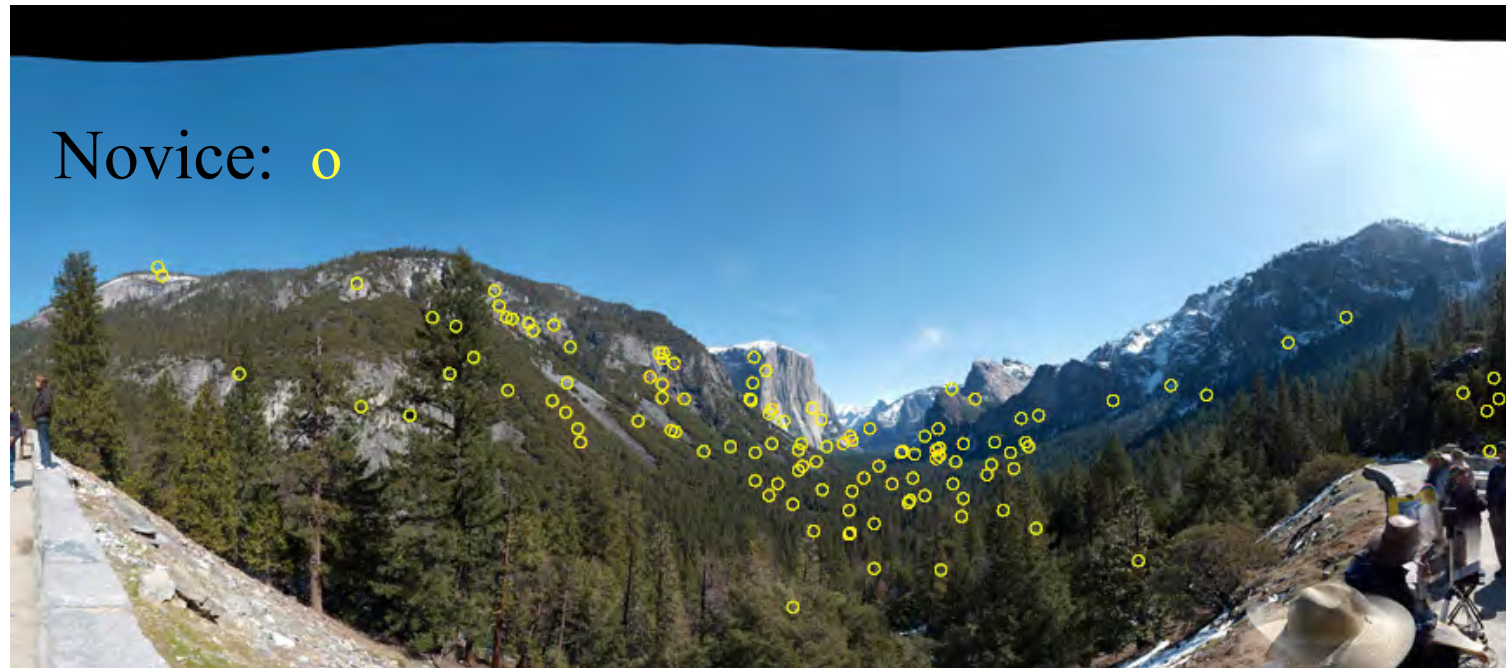


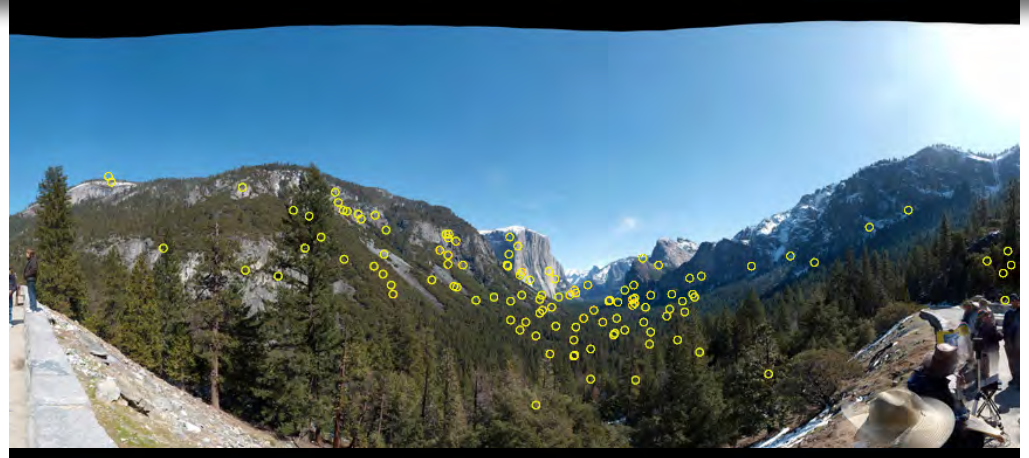
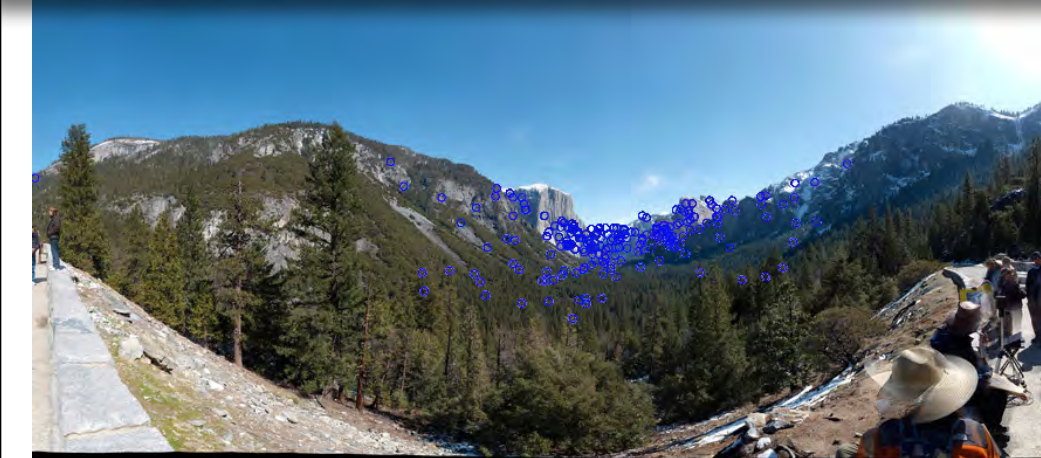






Common reference frame

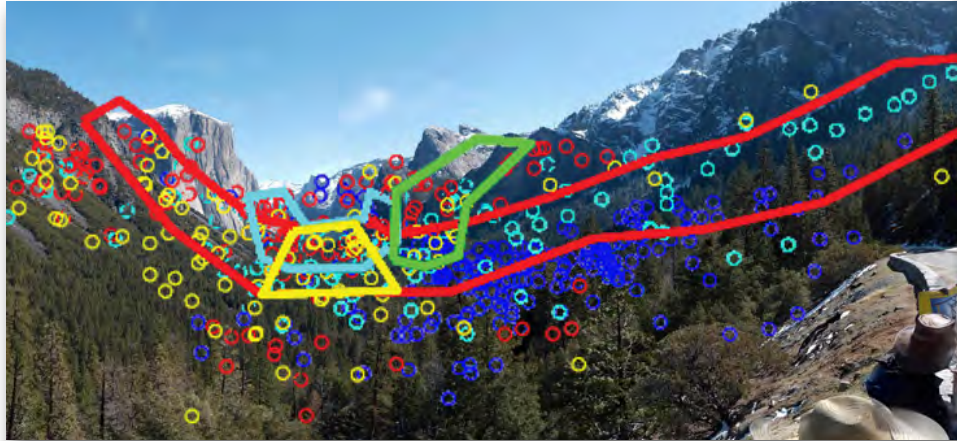




Semantic Analysis of Mobile Eyetracking Data

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Rochester, NY, USA



1st International Workshop on Pervasive Eye Tracking and Mobile Eye-Based Interaction



UBICOMP 2011
Beijing, China

Ubiquitous Computing
September 17-21, 2011