The TACOM Visual Perception Laboratory

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Report Documentation Page

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Abstract

Subject Terms

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Number of Pages
25

Recent Customers of the Visual Perception Lab Team

- FORD Motor Company, Scientific Research Labs
- General Motors, Technical Center
- NATO/U.S. Air Force
- U.S. Marine Corps
- U.S. Army NVESD
- U.S. Army NATICK
- U.S. Army AMSAA
- Numerous U.S. Army classified programs

The Visual Perception Lab Purpose

- Assess effectiveness of new signature treatments to vehicles relative to a baseline.
- Calibrate/validate human and sensor target detection models and simulations.
- Evaluate vehicle/system sensors for display systems.

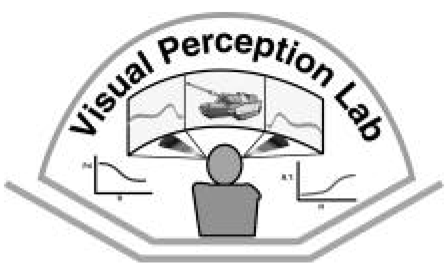
Organizing Data

Ground Truth

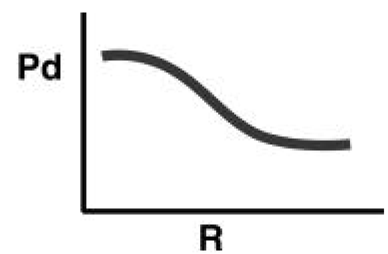
Contrast Values and

Image Statistics

Observer Results



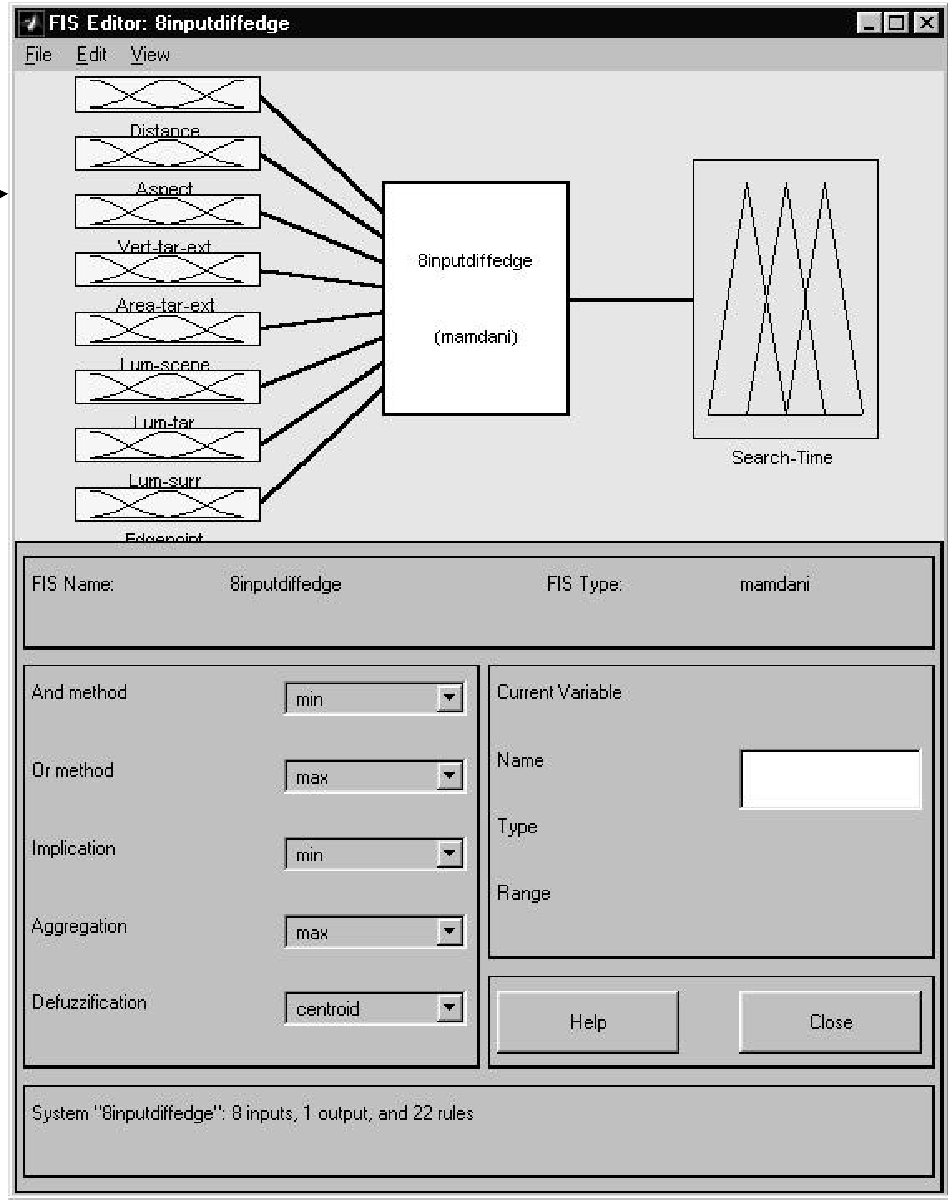
Data Base of Detection Probabilities versus Range



Computational Detection Model

Input factors:

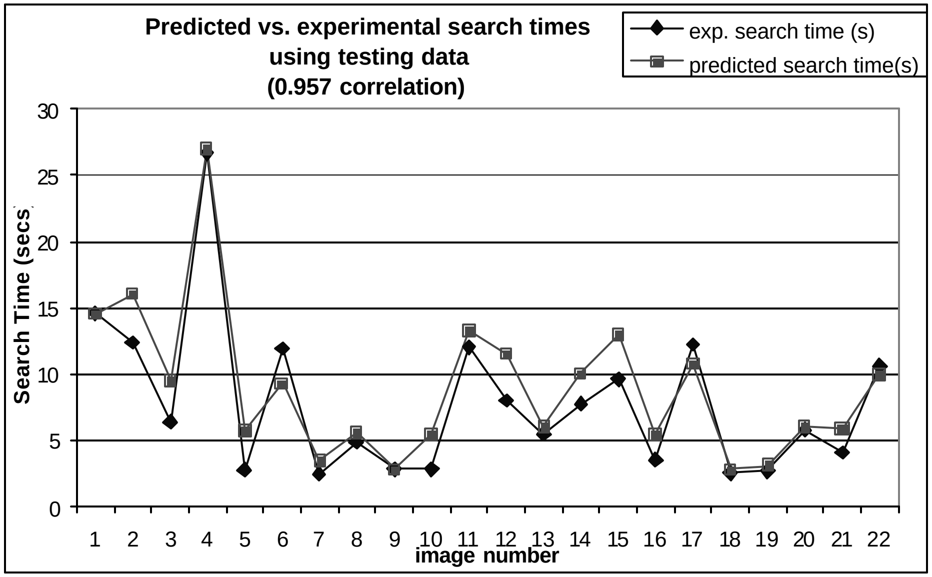
- range
- vehicle
- aspect
- luminance

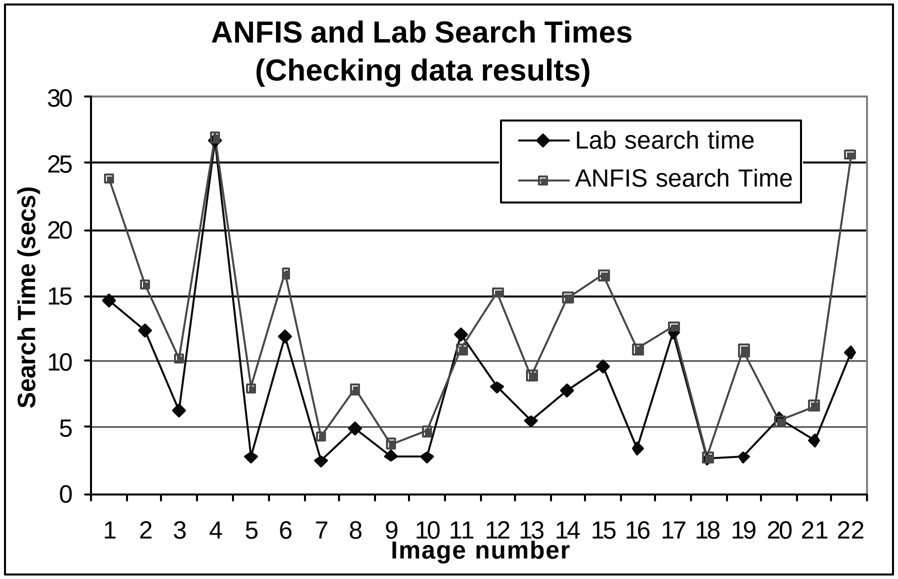


Output:

Detection Probability

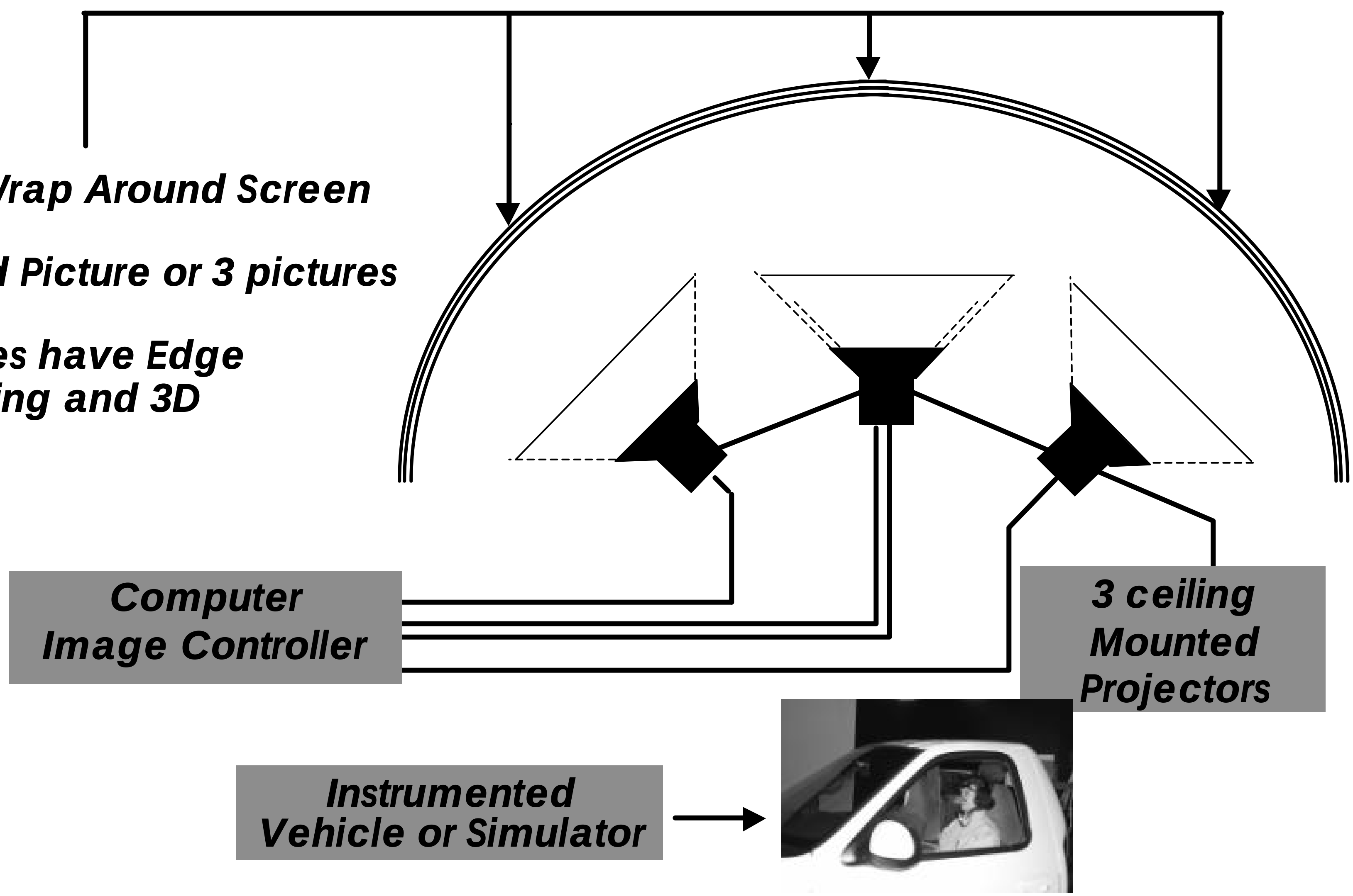
Experimental vs Computed Search Time
(95 % agreement to experimental values)



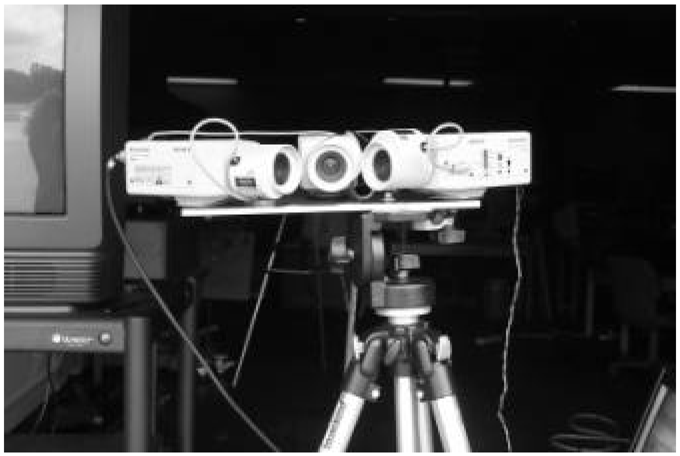


TARDEC Perception Laboratory Layout

- ***180° Wrap Around Screen***
- ***1-Solid Picture or 3 pictures***
- ***Pictures have Edge Blending and 3D***



Product of FORD CRDA Development of a 3-camera system to take high-resolution panoramic movies



CRDA and pending BAA with FORD Motor Company and Sarnoff

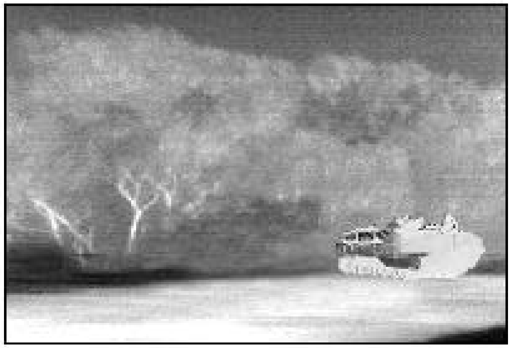
on Applying Vision Devices to Cars for Driver Assistance

IR-Visible fusion

Enhanced night driving without distraction

Visible detects colors
- sign information
- brake lights vs. headlights

Visible



IR

IR detects thermal information
- stealthy vehicles
- pedestrians and animals at night

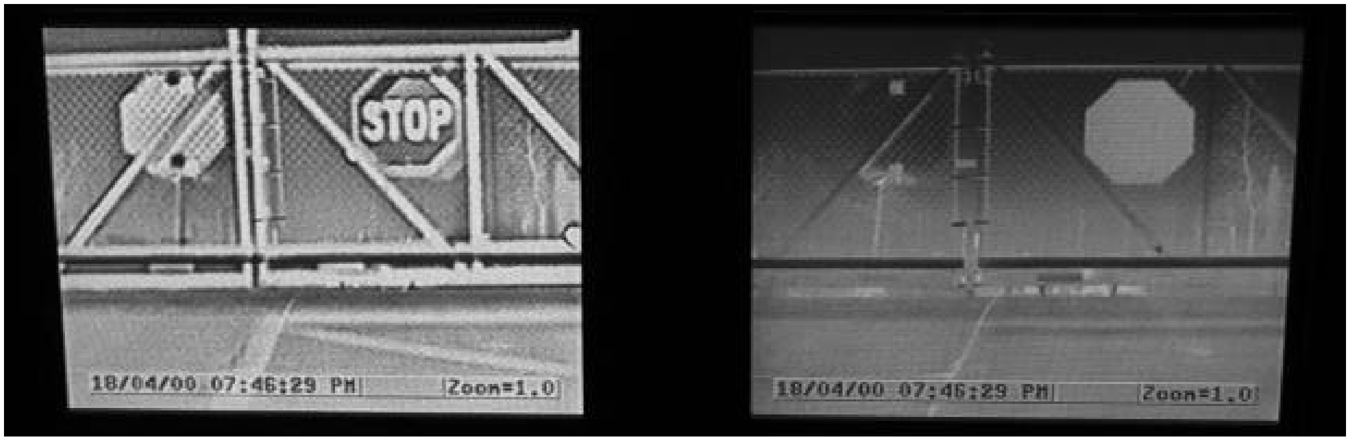
Visible and IR fused

CRDA and pending BAA with FORD Motor Company and Sarnoff
on Applying Vision Devices to Cars for Driver Assistance

IR-Visible fusion

Multi-sensor fusion

Visible and IR fused



IR

- IR+Visible combo gives all information on a single display
  - driver has context of IR image
  - reduced driver distraction than from multiple displays.
- Algorithms can be extended to include Millimeter Microwave
  - visibility through fog
  - visibility through rain at night

A TEST PROCEDURE FOR QUALIFYING CAMERAS FOR AUTOMOTIVE USE UNDER HIGH GLARE CONDITIONS

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Background

- Cameras for automotive collision avoidance and safety applications need to provide high contrast under both low light and high glare conditions.
- Most low light cameras perform well when the entire scene is dark, but, provide almost no contrast if there is a bright object in the scene.
- Even if the camera doesn't bloom, this lack of contrast makes the cameras unsuitable for automotive use.
- The authors have developed a testing procedure to rank the performance of visual video cameras for automotive use.

Experimental Procedure for Glare Test

- The authors have developed a testing procedure that evaluates a camera's ability to perform in situations where there is high light level in some areas and low light level in others.
- The procedure simulates the situation of looking into oncoming traffic at night.
- The test procedure is adapted from the detection experiment methodology used for evaluating vehicle camouflage and gives a quantitative measure of the resolving ability of the camera as the lighting level is varied.

Experimental Procedure for Glare Test cont.

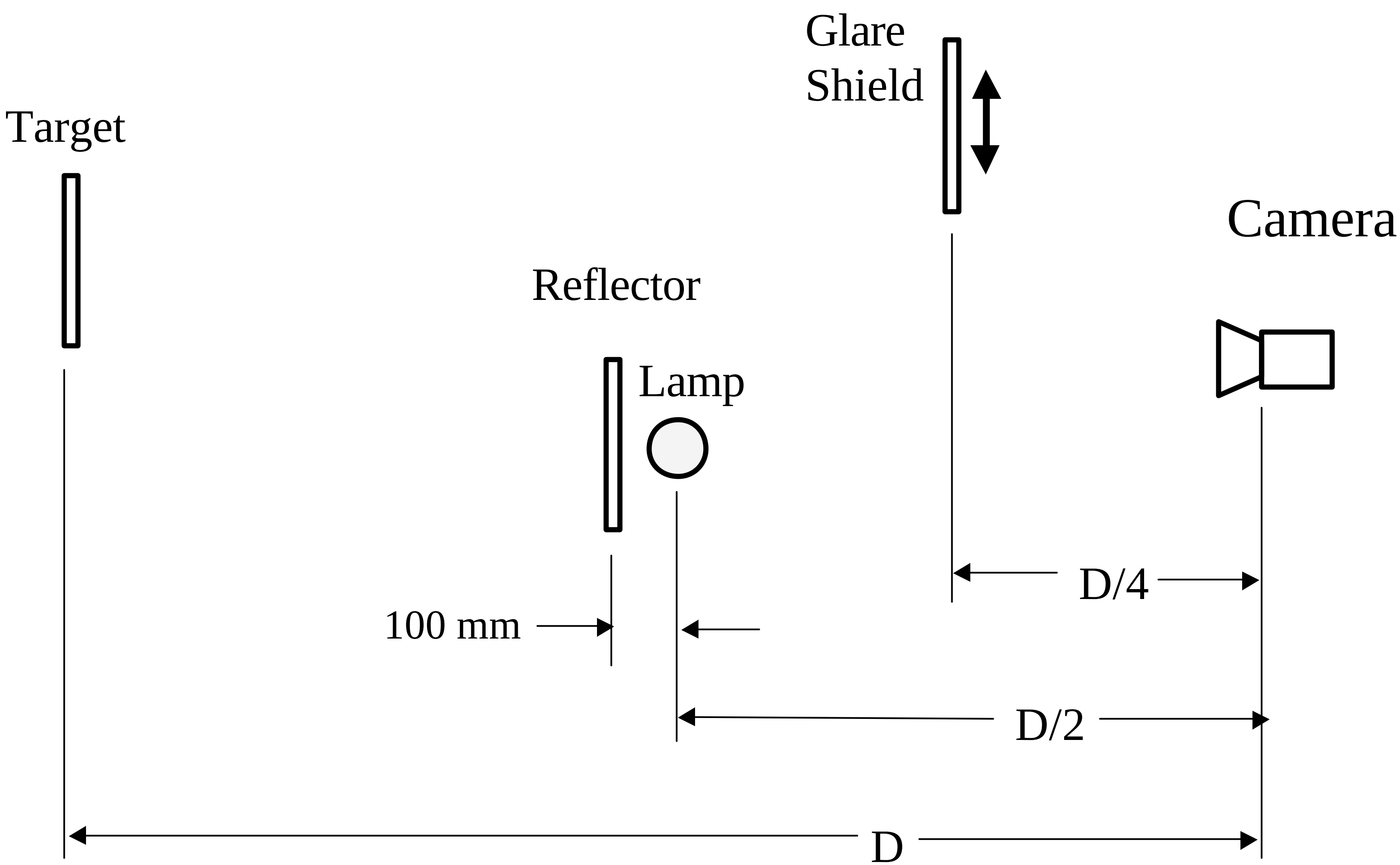
- The camera under test is focused on a USAF Tribar of a size that is easily resolvable in normal lighting. Slides showing the experimental set-up for this test follow.
- Camera performance under varying light conditions was assessed by progressively blocking off the image of the bulb, as seen by the camera, and recording the response from 4 observers as to how detectable the target appeared on a monitor. The detectability levels were as follows:
    - can see nothing (0)
    - can tell something is there (1)
    - can resolve 2 separate groups of something (2)
    - can clearly resolve one group of 3 bars (3)
    - can clearly resolve both the horizontal and vertical bars (4).

Experimental Procedure for Glare Test cont.

- The test began with the light bulb fully exposed to the camera. The camera's view of the light bulb was then randomly blocked with a black shield at different positions.
- The observers were asked to assess the detectability of the target for 20, 40, 60, 80 and 100 % blocking of the bulb. Light levels at the camera and the targets were measured for each test with a Photo Research spectrophotometer.

Glare Test Experiment Set Up

Experimental Setup to measure detectability of AF 3- bar targets



Cameras tested

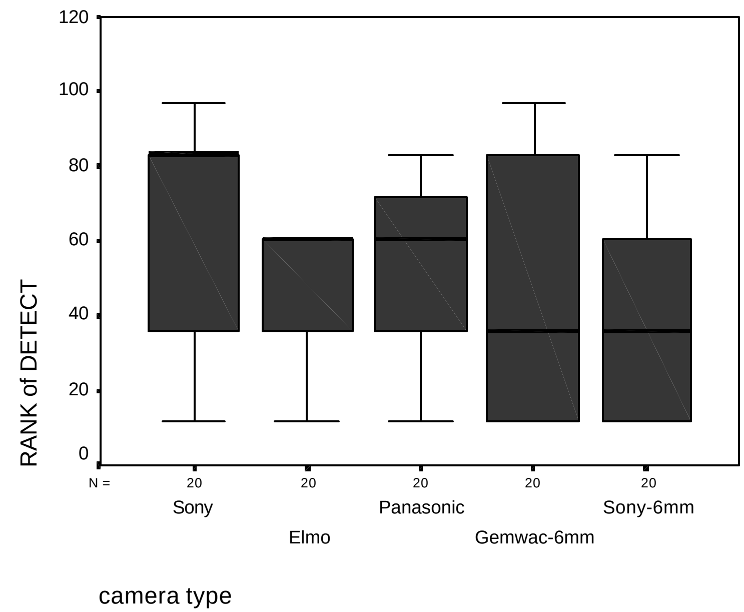
Camera Name	Picture elements	Min. Illumination
ELMO QN42H	786 X 494	20 lux
Panasonic GPKS162	768 X 494	3
Sony DC50A	768 X 494	0.8
Genwac GW-902H	768 X 494	0.0003

Results of Glare Test

camera type

Dependent Variable: RANK of DETECT

camera type	Mean	Std. Error
Sony	61.50000	3.288
Elmo	45.90000	3.288
Panasonic	55.12500	3.288
Gemwac-6mm	50.40000	3.288
Sony-6mm	39.57500	3.288



The SONY camera had the best performance for detection over the wide range of luminance.

Experimental Procedure for Dynamic Range Test

- A second series of tests were performed on three of the original test cameras using two resolution targets illuminated at different light levels.
- Varying the incident light level in detectability increments created a detailed characterization curve of these cameras. The light level was measured at the target with a photometer. See the following figures for the experimental setup.
- The targets were displayed in "cubby holes" one meter on a side which allowed dramatically different light levels to be used on the targets. The targets were illuminated by 150-watt spotlights whose brightness could be changed by the use of individual variable transformers.
- The distance from the tested camera to the target was adjusted to achieve the scene shown on the monitor.

Experimental Procedure for Dynamic Range Test cont.

Image of bar targets seen under normal lighting

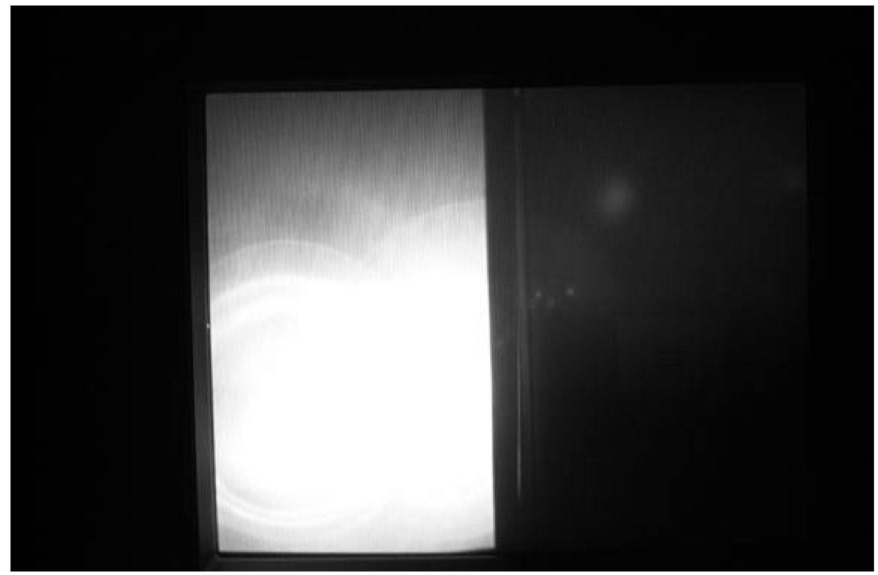


Image of bar targets from monitor and camera under wide luminance range

Experimental Procedure for Dynamic Range Test cont.

Experimental Procedure for Dynamic Range Test cont.

- The tests began with both targets illuminated at a level just sufficient to allow resolution of both targets.
- The light level on the left target was held constant during the experiment while the light on the right target was increased until the resolution degraded.
- Progressive degradation as the light level at the target was increased was reported by the 4 observers and recorded using the same 0 to 4 scale used in the previous experiments. The light levels at that target were recorded when a transition in detectability was reported by a majority of observers.
- This test yielded a relationship between detectability and light level as the illumination on the target is increased beyond the optimum level. This relationship is important for automotive applications since it is rarely possible to achieve any control over scene lighting much less achieve optimal conditions.

ANOVA Table

Tests of Between-Subjects Effects

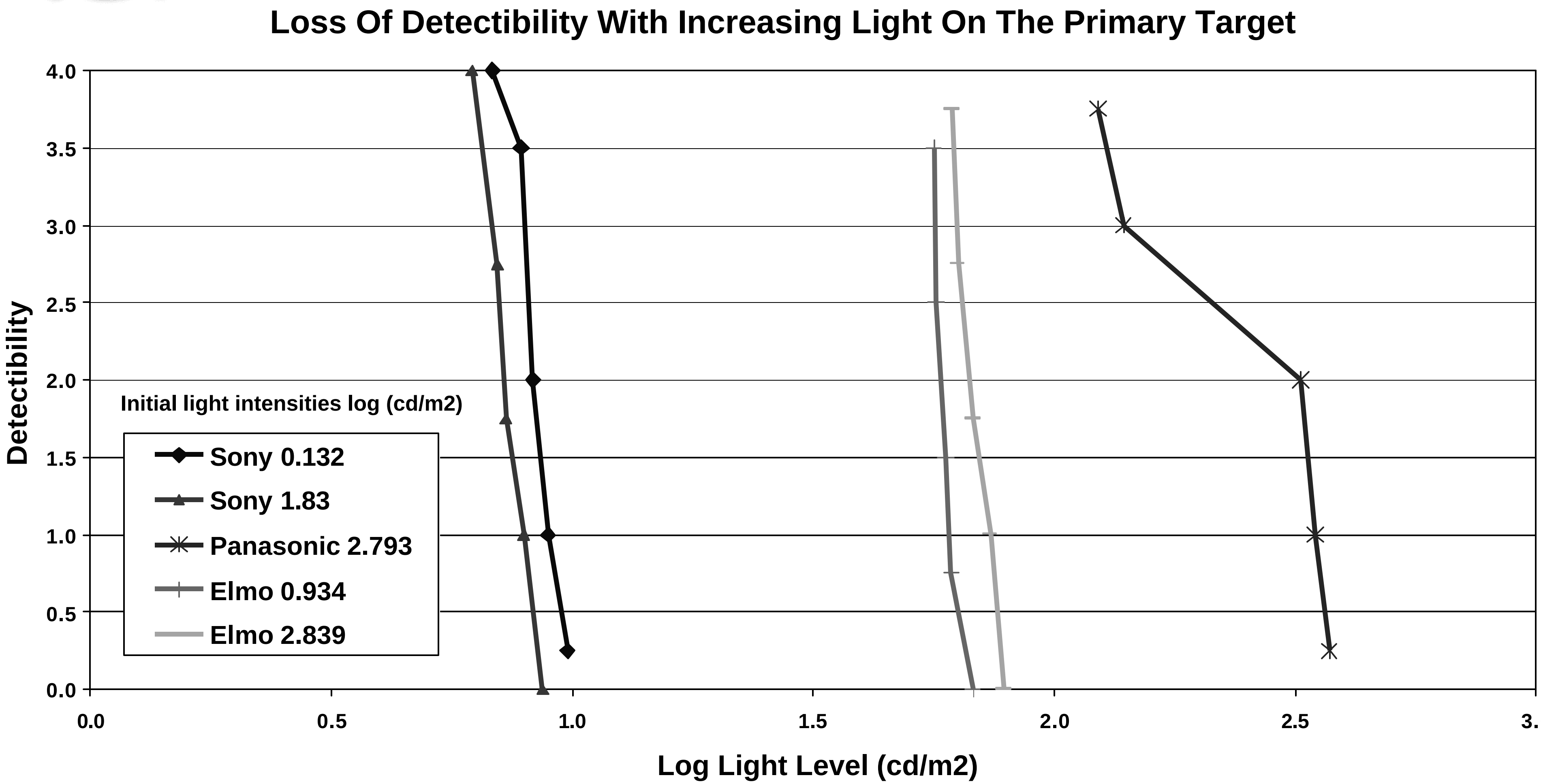
Dependent Variable: RANK of DETECT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Corrected Model	0034.390[b]	11	5457.672	25.237	.000	277.607	1.000
Intercept	255025.0	1	255025.0	1179.269	.000	1179.269	1.000
CAMERA	5658.325	4	1414.581	6.541	.000	26.165	.989
POSITION	4326.025	4	3581.506	62.803	.000	251.211	1.000
SUBJECT	50.040	3	16.680	.077	.972	.231	.063
Error	9030.610	88	216.257				
Total	334090.0	100					
Corrected Total	9065.000	99					

a. Computed using alpha = .05

b. R Squared = .759 (Adjusted R Squared = .729)

Results of Dynamic Range Test



The imaging performance of the 3 cameras under 5 incident light intensities separated in to three sensitivity regimes.

Value Added by the Visual Perception Laboratory

- To provide a validated, secure, and low-cost way to generate realistic performance data for vehicle design, evaluation and acquisition decisions for signature management and target acquisition.
- To analyze vehicle and display sensor designs and evaluate performance regarding human visual perception in search, target acquisition.
- To analyze the interactions among signature management, obscurants, atmospherics and terrain .
- To test and evaluate vehicle concepts early in the design cycle when changes can be made economically.
- To reduce development cycle time and cost, while improving confidence in performance.