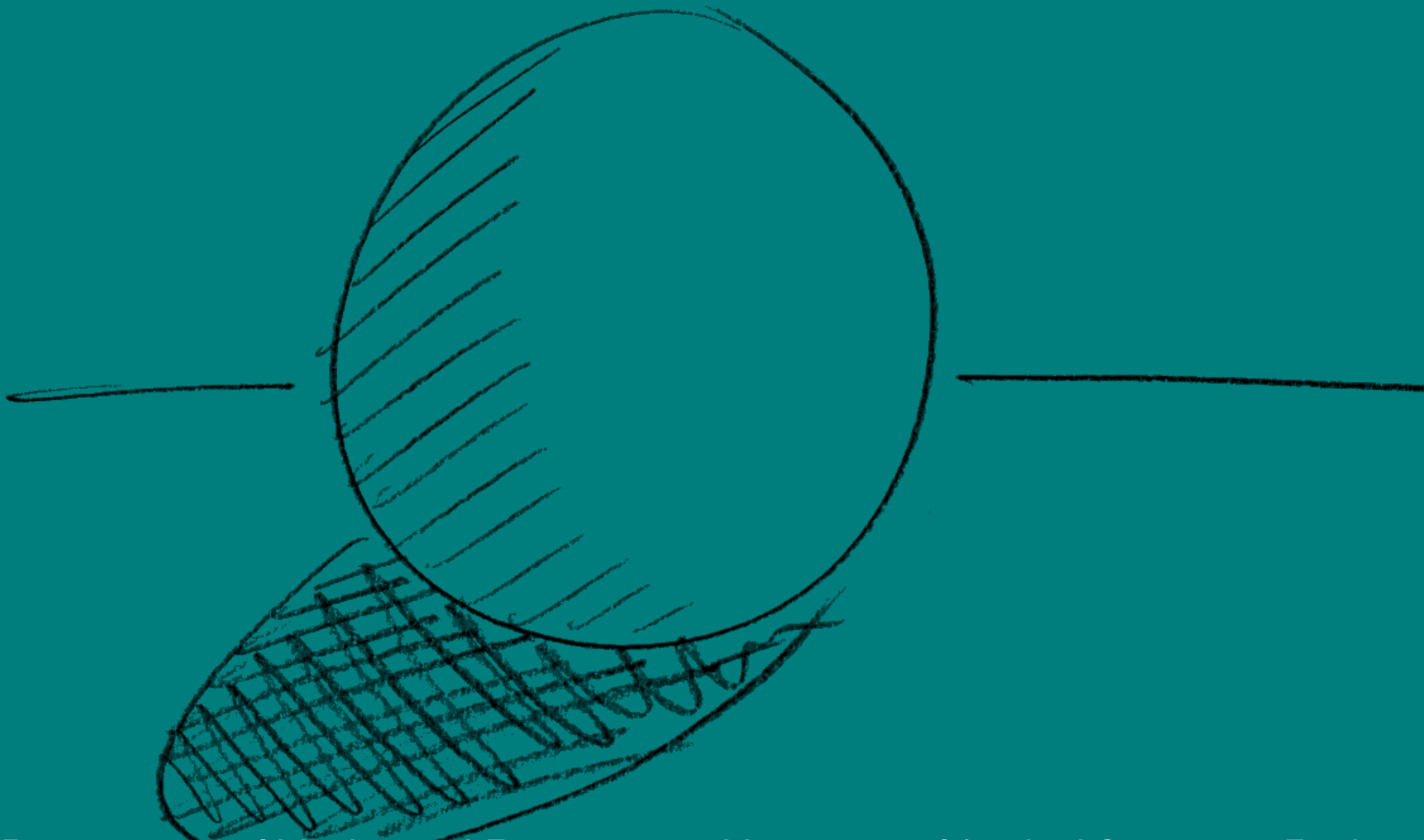


Gernot Hoffmann

...What is Computer Vision ?



Department of Mechanical Engineering · University of Applied Sciences · Emden

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?

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Leonhard Euler
1707 - 1783

Best View

Zoom = 100%
Ctrl + 1

Menue Bars Off
F8 / F9

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Contents

1 Introduction

What is Computer Vision ?

A science - and a lecture by the author

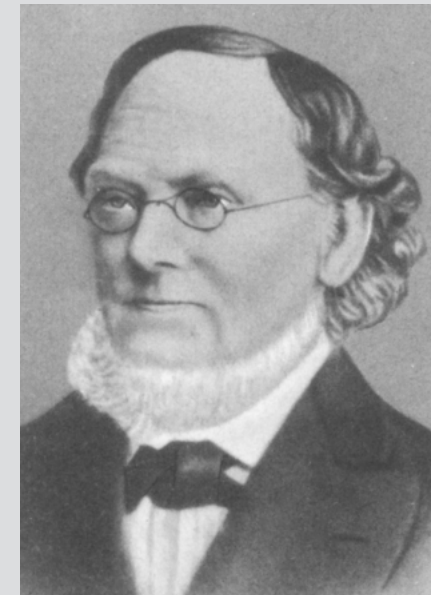
The lecture was initiated by an attempt to describe computer graphics and photogrammetry by the same mathematical nomenclature

Color handling gained more and more importance

Writing down the lecture, it turned out that advanced Paper and Web publishing programs were required

Finally, the lecture Computer Vision contains geometry mathematics, image processing, computer graphics, photogrammetry, color science and media techniques

CV is not a lecture about commercial programs, though we refer often to Photoshop and PageMaker



Hermann
Graßmann
1809 - 1877

This doc contains
the illustrations
for an introduction
into
Computer Vision

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Contents

2 Basic Transformations / Workstation 2D-Transformation

Graphics Elements in a
metaplane

Any set of coordinates

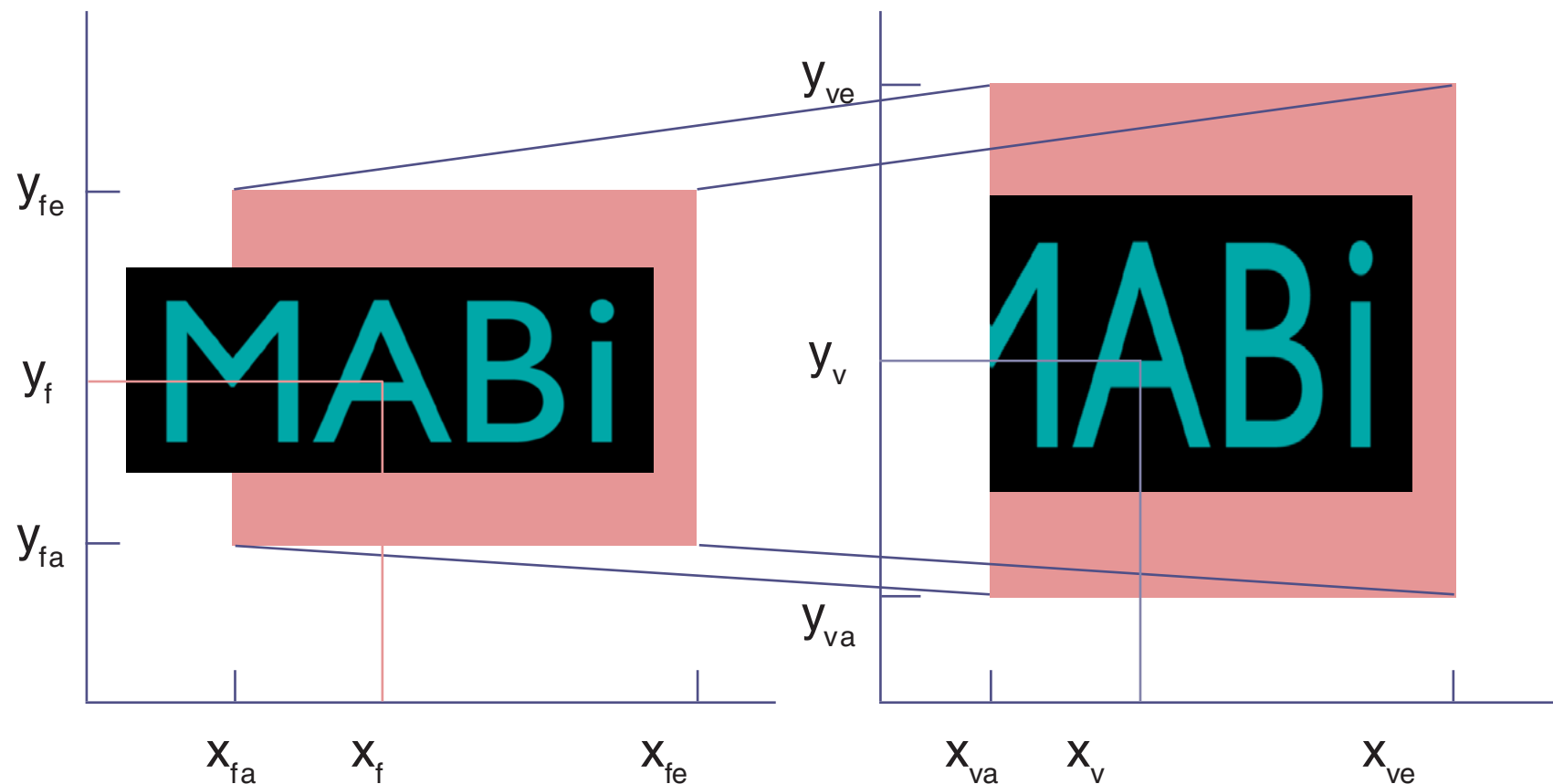
Source area by Frame

Graphics Elements in a Device
Printer, monitor or page

Device specific coordinates

Destination area by Viewport

$$x_v = x_{va} + (x_f - x_{fa}) \frac{x_{ve} - x_{va}}{x_{fe} - x_{fa}}$$



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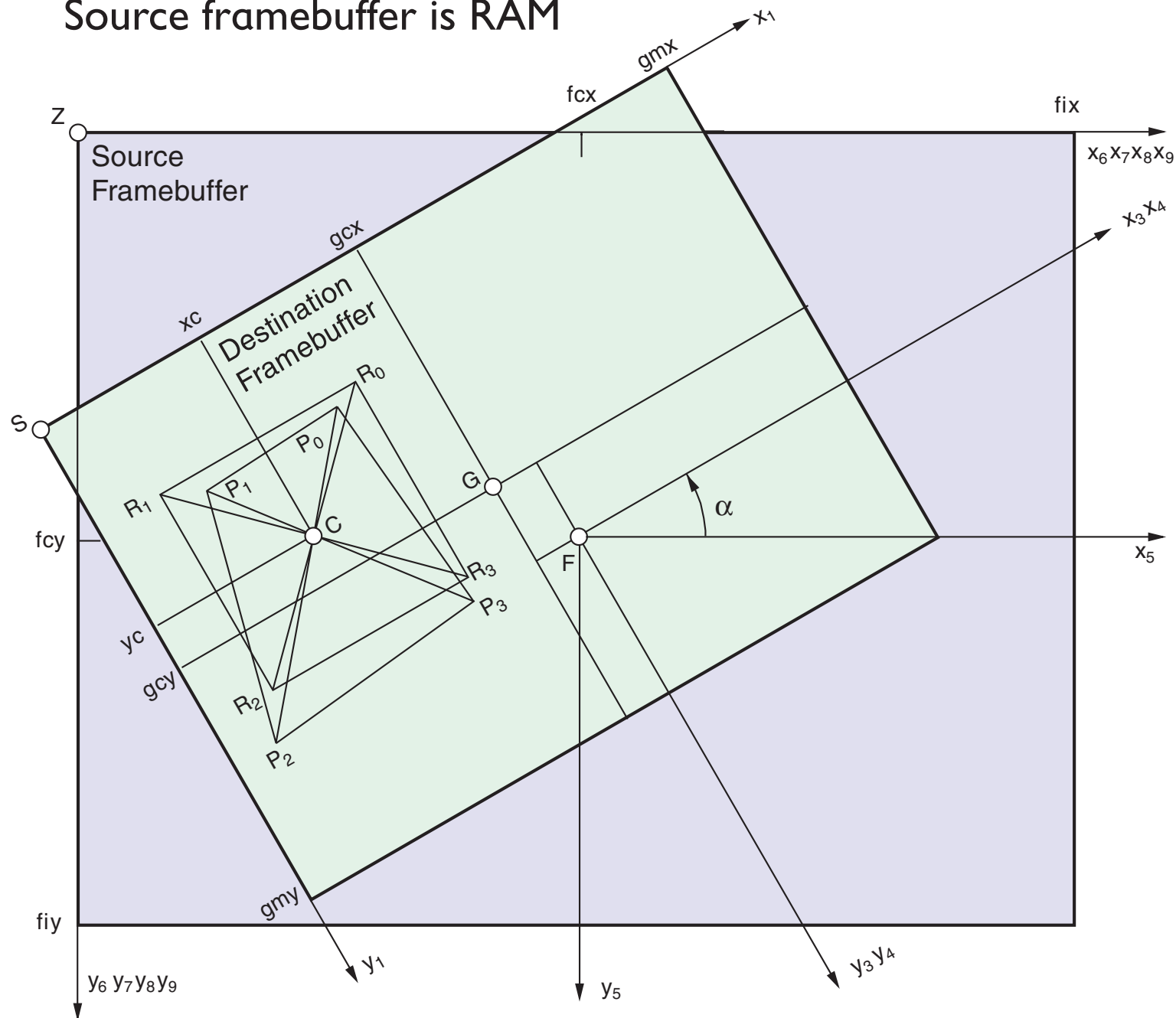
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2 Basic Transformations / 2D-Transformation / Memory Mapping

Destination framebuffer is RAM or VRAM (Graphics Card)

Source framebuffer is RAM



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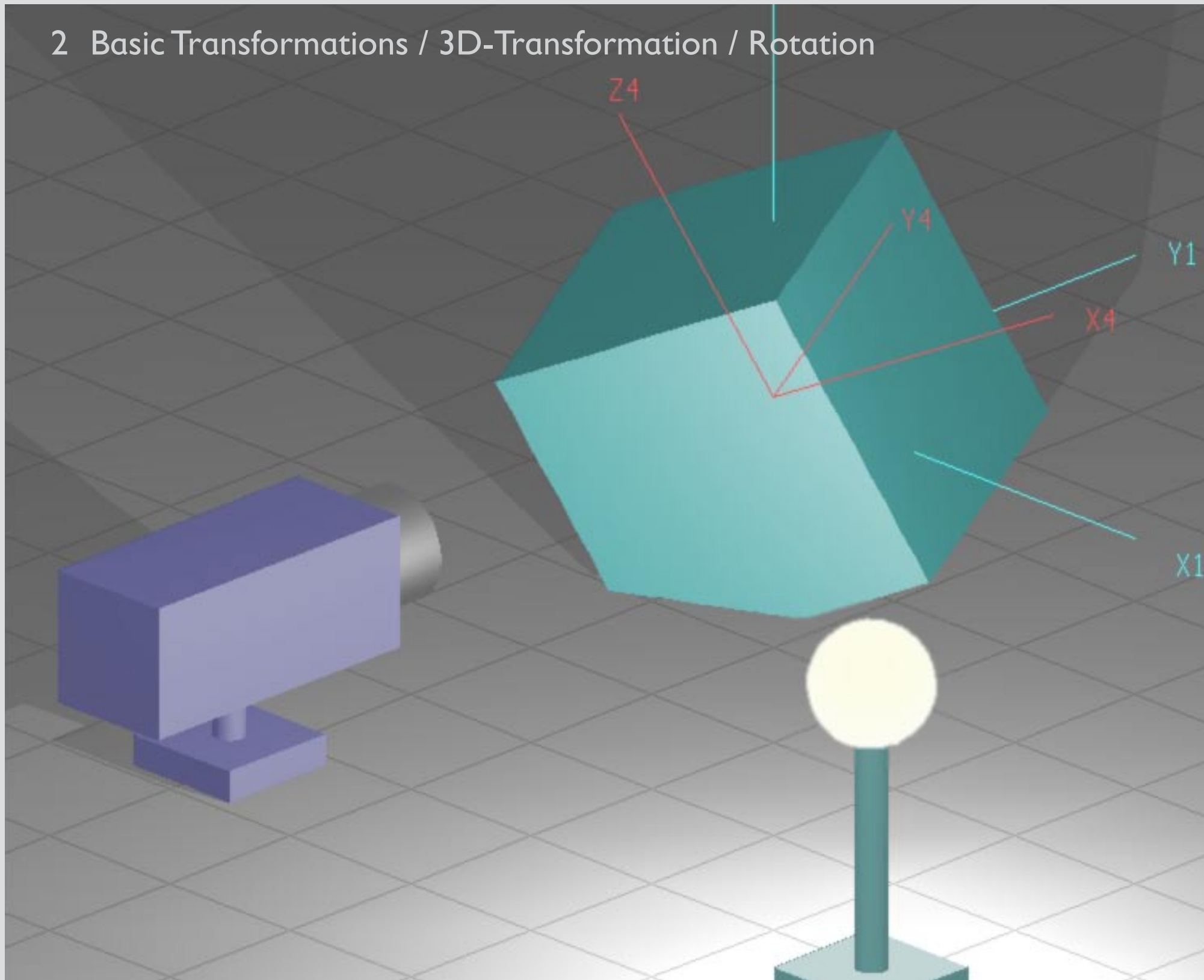
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Contents

2 Basic Transformations / 3D-Transformation / Rotation



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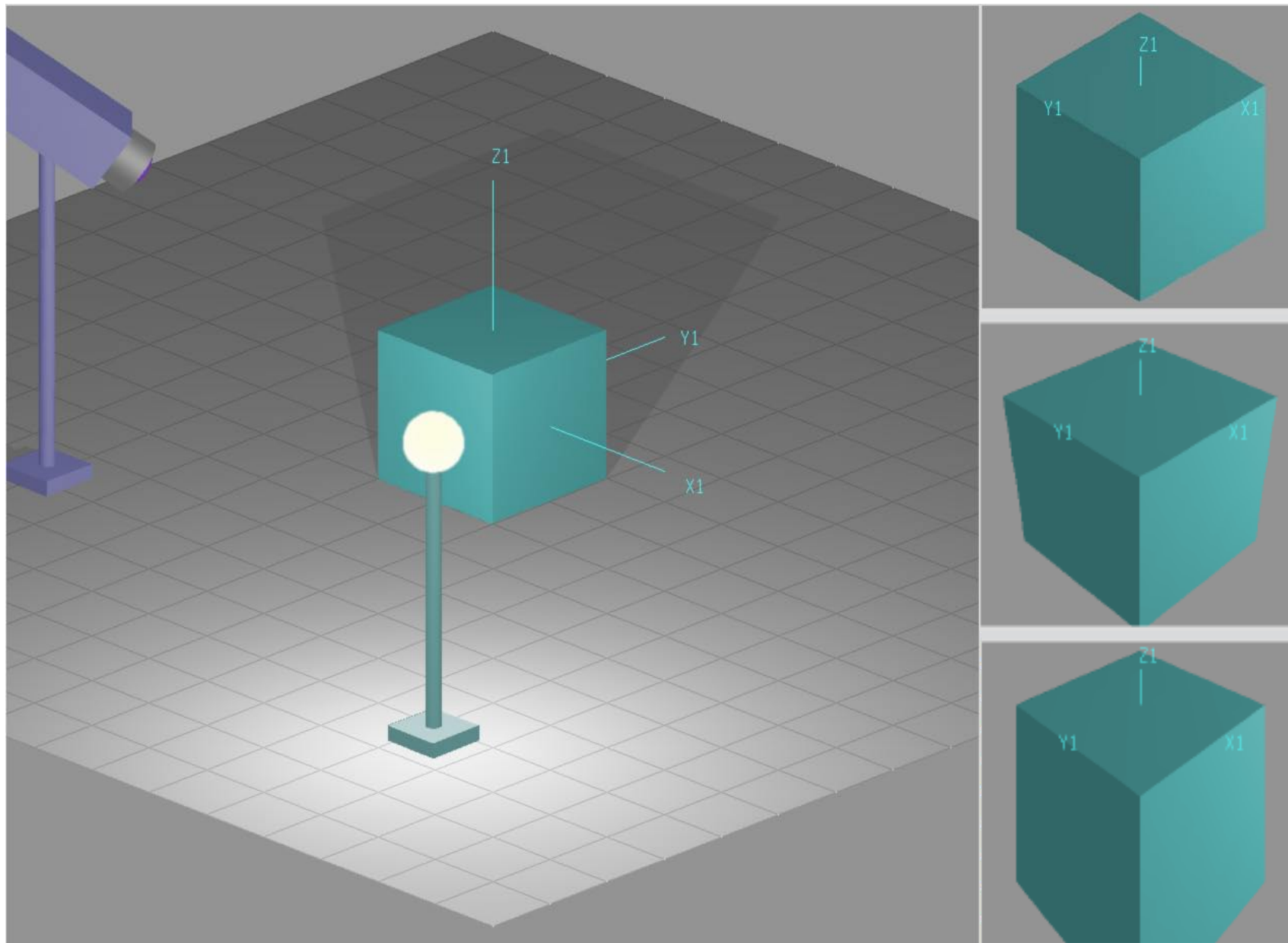
Contents

3 Projections for Computer Graphics

Isometric by camera position at infinity, a mathematical construct

Normal by natural camera position, perspective projection

Rectified by natural camera position and tilted image plane



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Isometric

Normal

Rectified
Verticals

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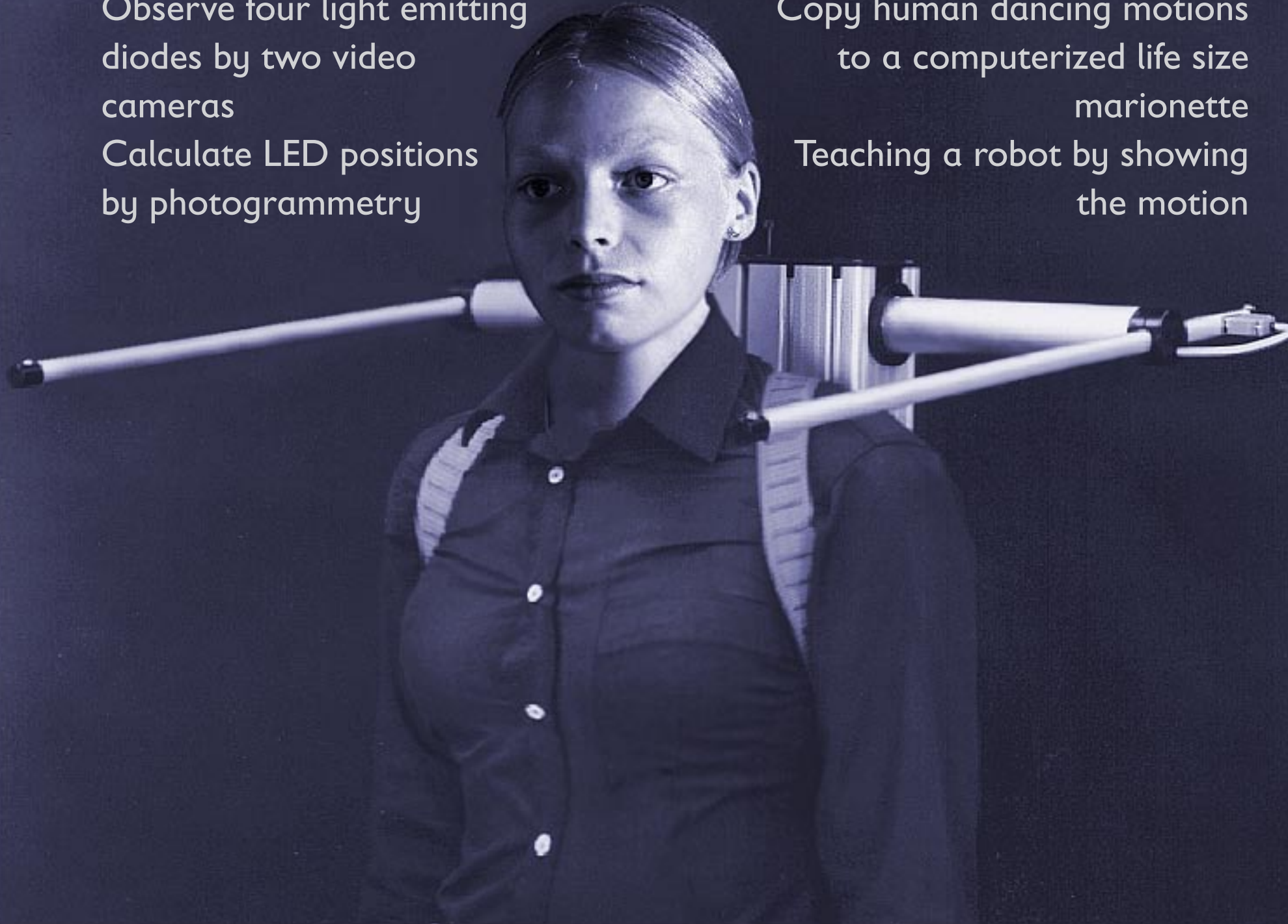
4 Photogrammetry / Video Motography

Observe four light emitting diodes by two video cameras

Calculate LED positions by photogrammetry

Copy human dancing motions to a computerized life size marionette

Teaching a robot by showing the motion



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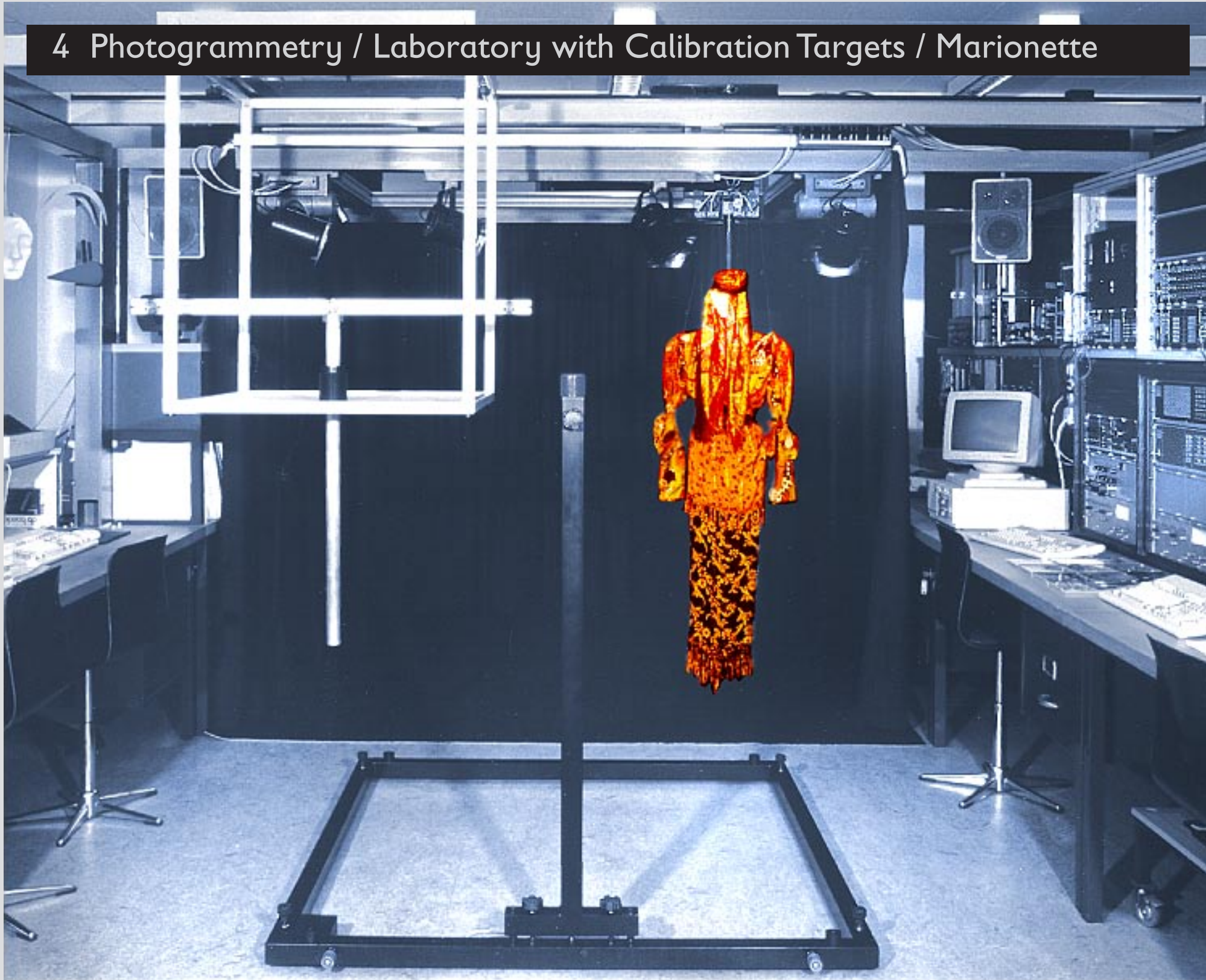
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4 Photogrammetry / Laboratory with Calibration Targets / Marionette



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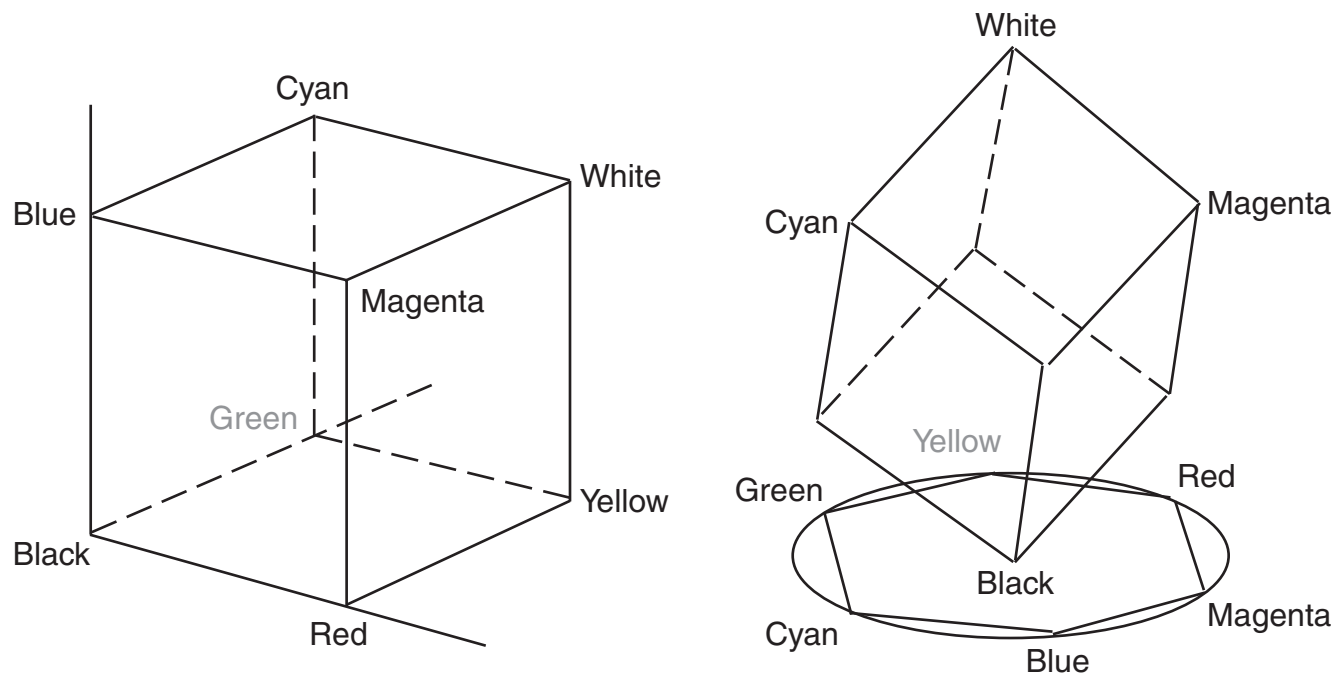
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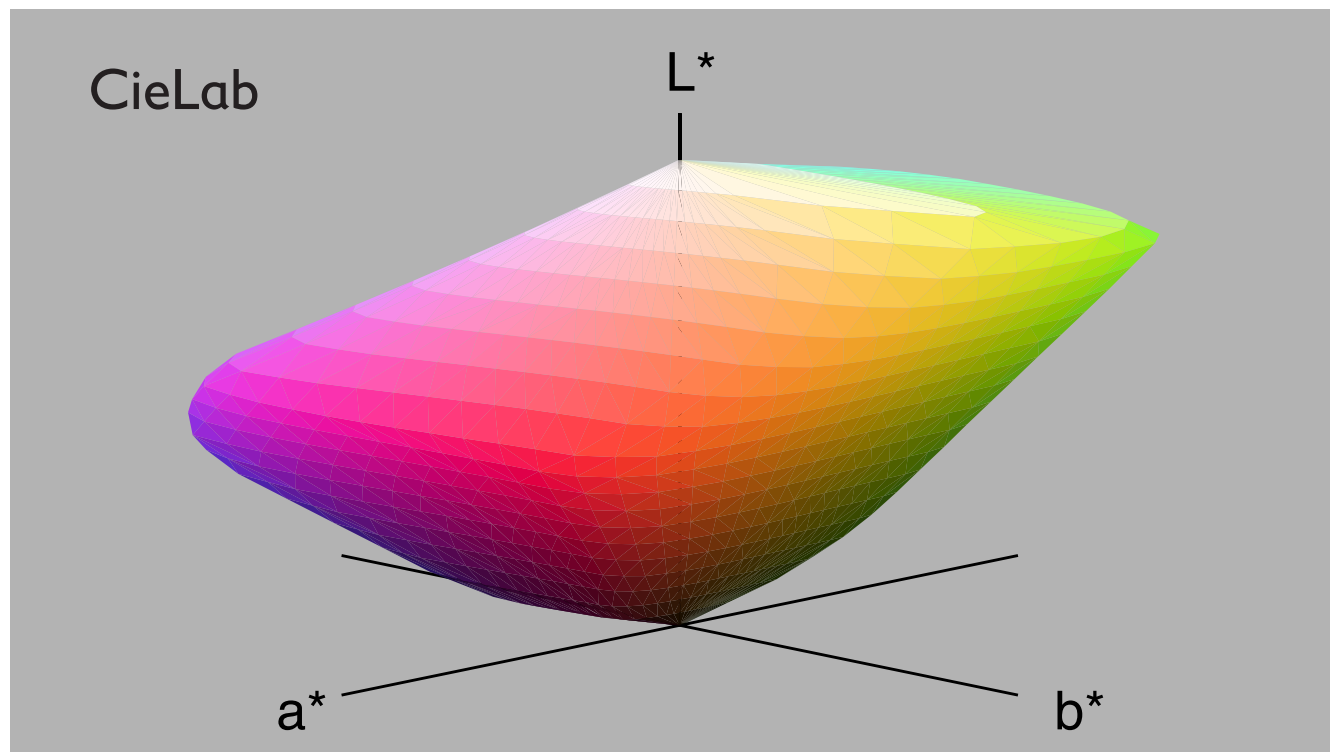
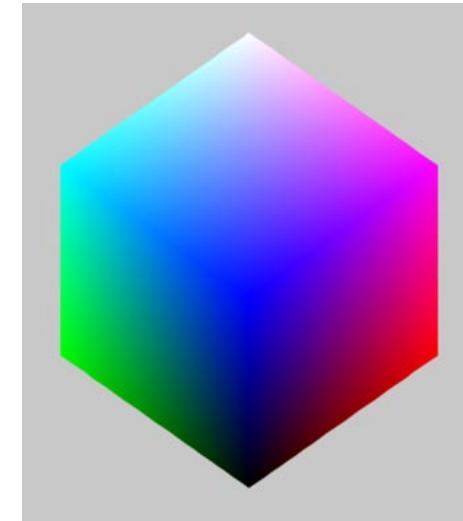
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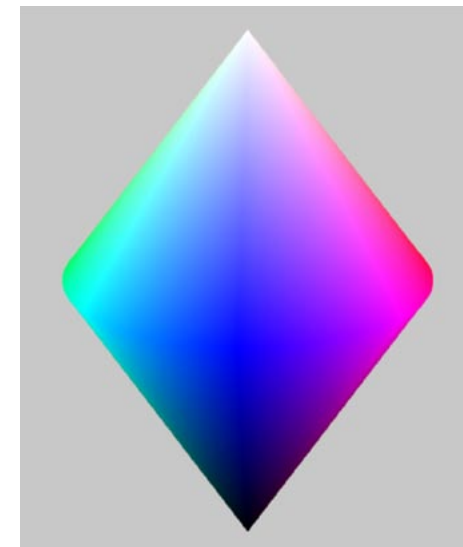
5 Color Systems / RGB Cube / HLS Doublecone / Physical CieLab Space



RGB Cube



Hue / Lightness / Saturation Cone



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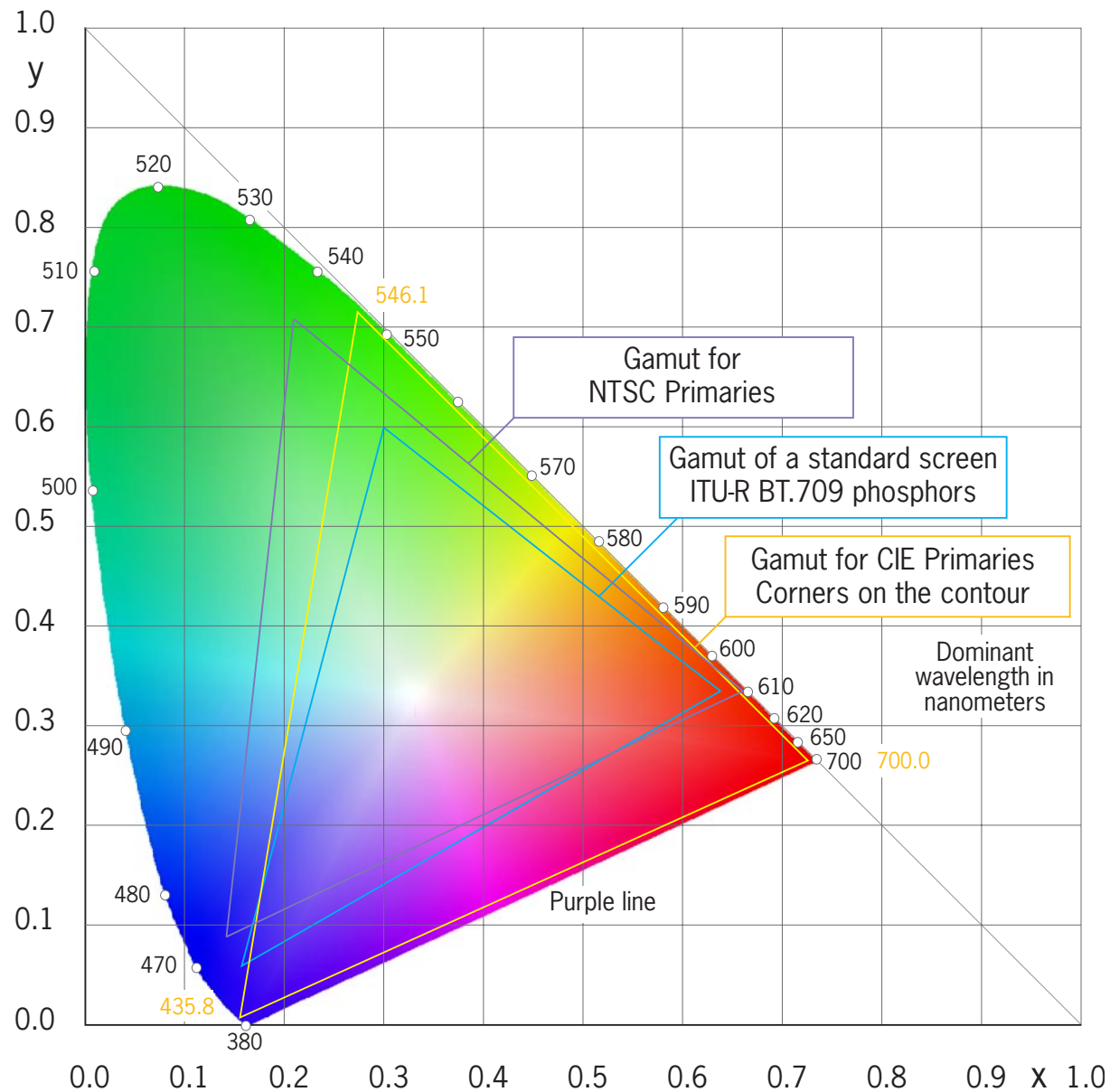
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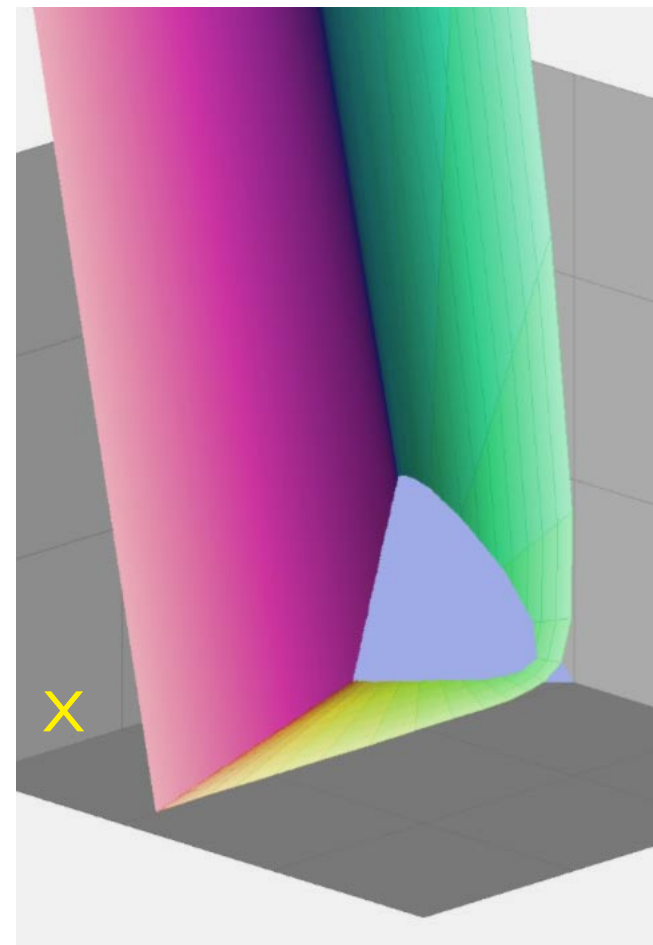
5 Color Systems / CIE Chromaticity Diagram

Illustration of visible colors in a plane x,y
RGB gamuts are represented by triangles



Volume of visible colors in
XYZ coordinates

Based on color matching
principles by H. Graßmann



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Contents

6 Color Management / Consistent Colors in Product Development

Graphics Products

Poster

Brochure

Book

Package

Web information

Traffic information

Industrial Products

Traffic Car / Bike / Van / Boat / Train / Aircraft

House Kitchen / Garden / Bathroom / Tiles /

Furniture / Textile / Table-ware

Fashion Cloth / Shoes / Jewellery

Sports Equipment / Fashion

Food Drink / Food

Tech Audio / TV / Video / Watch / Camera

Industry Tool machine / Robot / Transport

Medical X-Ray / Dental equipment / Ultrasonic

Swatch Books

CMYK

HKS

Pantone Spot / Process

Hexachrome / Metallic

Pantone Film / Foil

Sample Collections

RAL

Textile / Carpet / Tiles

Pantone Plastic

Pantone Textile

Integrate swatches and samples into a computer controlled workflow

Colors are measurable by instruments – but perception is subjective

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6 Color Management / Workflow

Calibrate Monitor

- by Hardware
- by Adobe Gamma
- by Instrument

Calibrate Printer

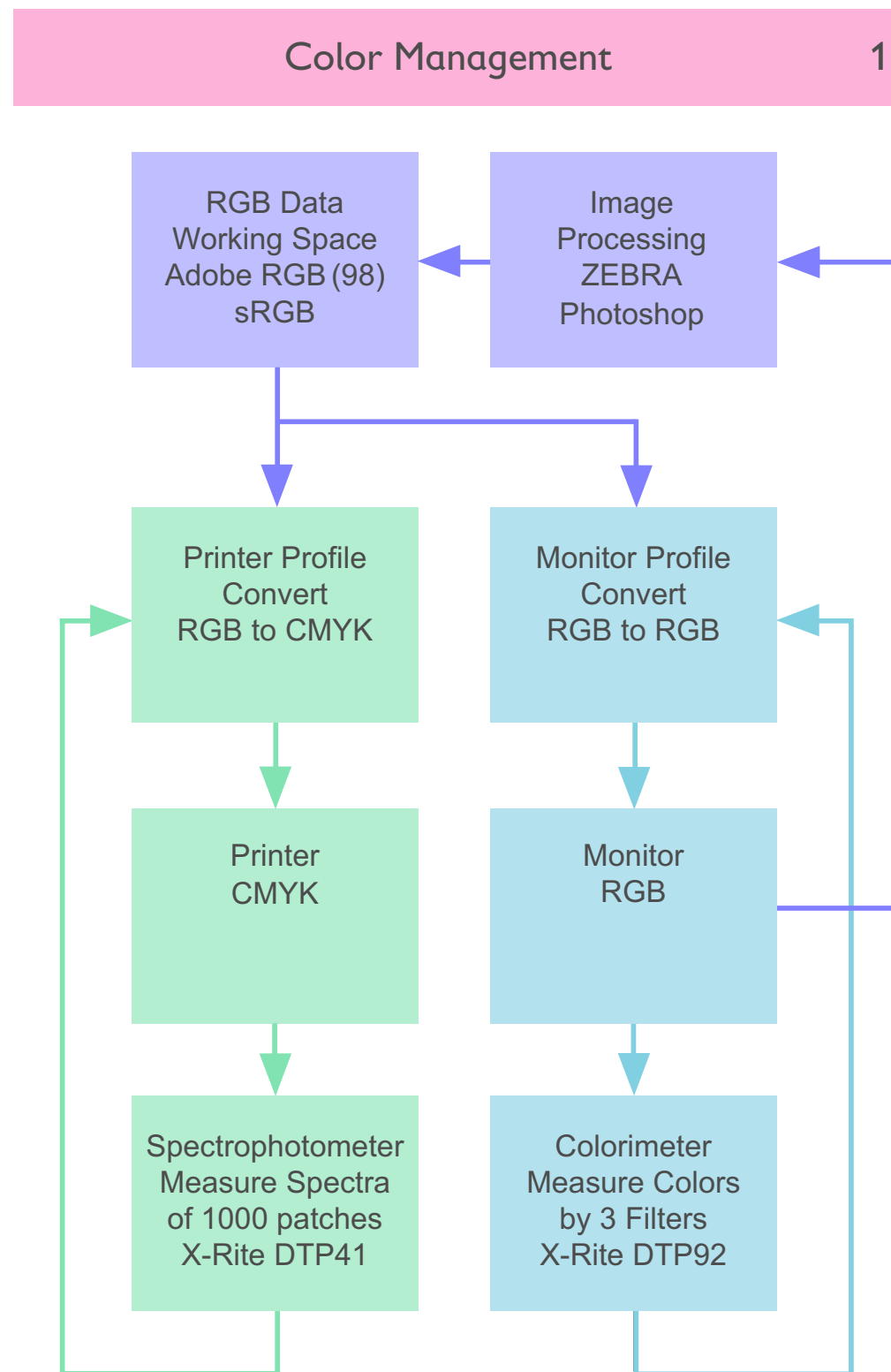
- by Instrument

Define Working Space

Optimize Images by
appearance on monitor

Result

Working Space RGB-Data
which refer accurately to
physical colors



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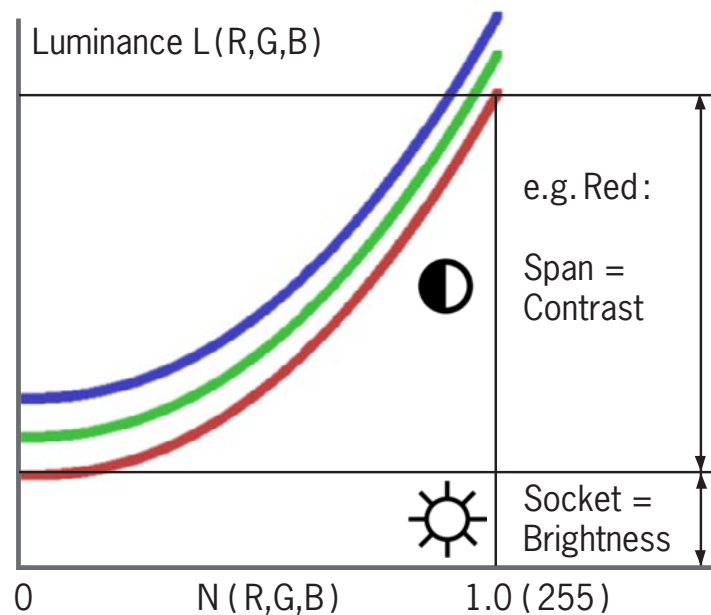
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6 Color Management / Monitor Calibration

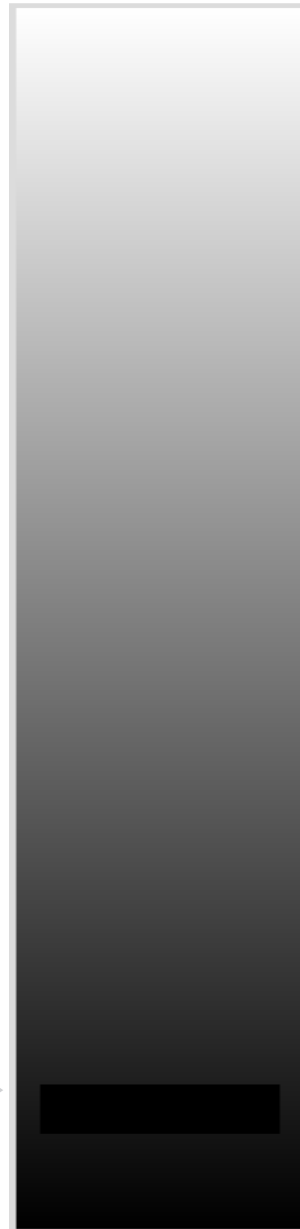
Web document caltutor270900.pdf / Adjust your monitor

Hardware Monitor Calibration



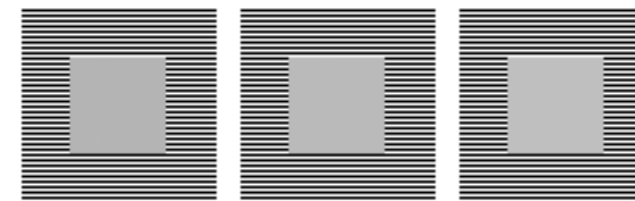
$$\text{Luminance} = (\text{Brightness} + \text{Contrast} \cdot N)^{\text{Gamma}}$$

- 1 Let your monitor warm up one hour
- 2 Adjust Contrast to maximum
- 3 Adjust Brightness for Black
Brightness is not used for White
A black rectangle should be visible (arrow)
- 4 Adjust Contrast for White luminance
- 5 Try to balance all colors until the Grayscale shows no tint of any color
- 6 Shift to red gray: Standard D65 6500 K
Shift to blue gray: Standard Monitor 9300 K



This image should show natural colors

Gamma Test Patterns



2.0 2.2 2.4

Equal Gray for inner and outer square
Adjust Gamma = 2.2

Use Zoom 100% or 200%

Browsers are not accurate

Please download and view by Acrobat

3

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Best View
Monitor G=2.2

Zoom = 100%
Ctrl +1

Menu Bars Off
F8 / F9

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6 Color Management / Printer Calibration

Print about 1000 color patches

Read patches by Spectrophotometer

Build color correction table / ICC Profile

Result: print is as accurate as possible



ICC Profiles are valid only for a specified process

- Printing machine
- Actual ink cartridges
- Paper or other media
- Resolution
- Dithering mode
- Ink limit setting
- Dark/light ink transition
- Undercolor removal
- Rendering Intent

High quality printing programs are called Raster Image Processors (RIPs)

We use Onyx PosterShop Pro and Best Colorproof

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7 Image Processing / Geometry / Interpolation

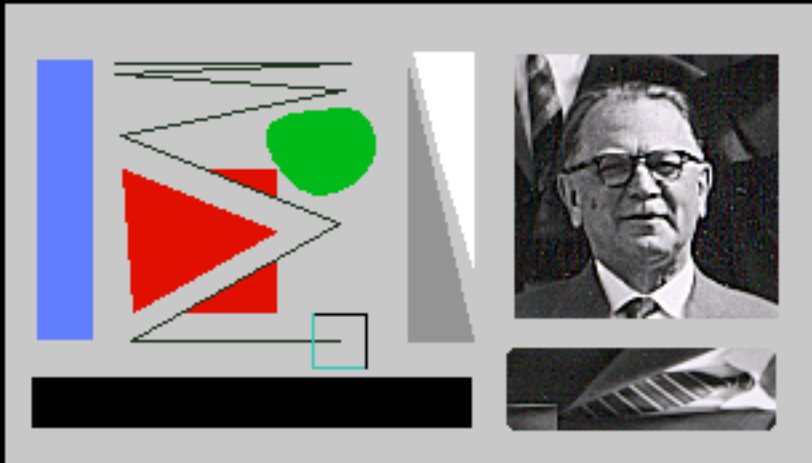
Rotation, scaling, morphing and perspective rectification require subtle interpolation algorithms

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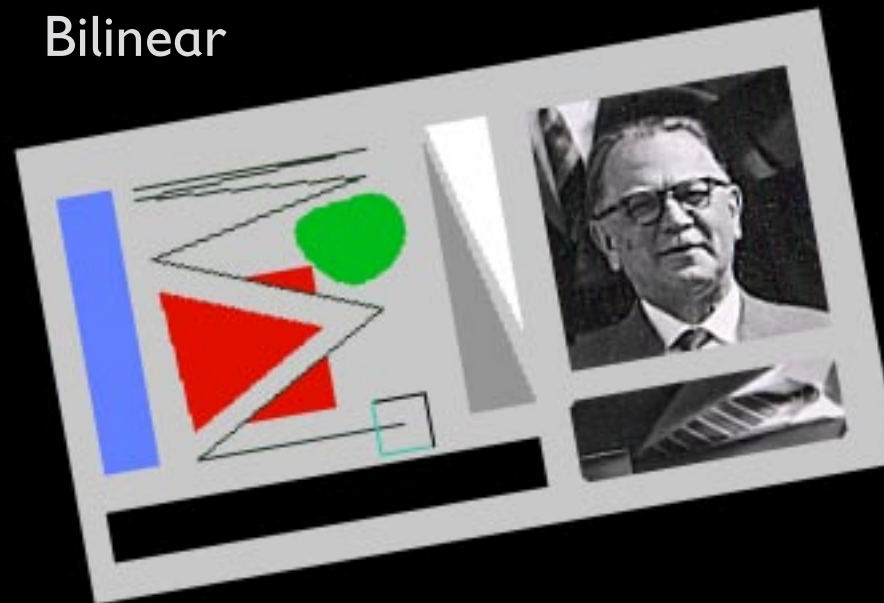
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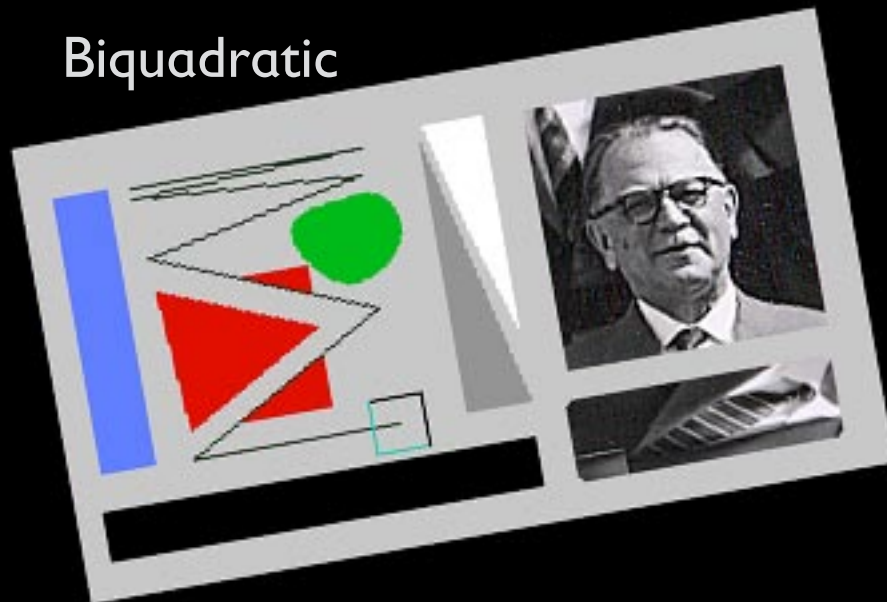
Original



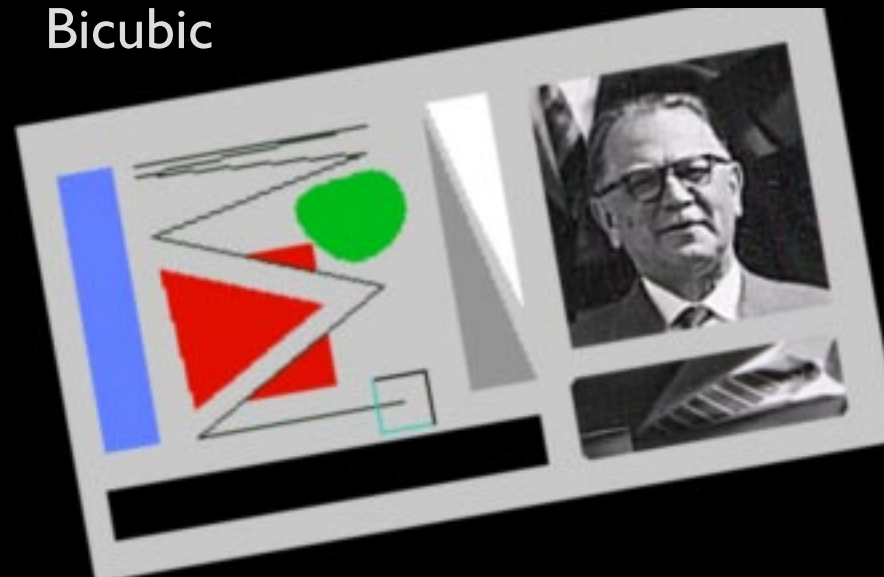
Bilinear



Biquadratic



Bicubic



7 Image Processing / Geometry / Morphing

Perspective rectification
Four lines, one mouse click



Morphing
Circle shows affected area



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7 Image Processing / Light Effects

Light effects by simulating the illumination of a paper photo by lamps

Artificial color illumination for the glass sphere and the cube



Darker environment and soft white light



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7 Image Processing / Filtering

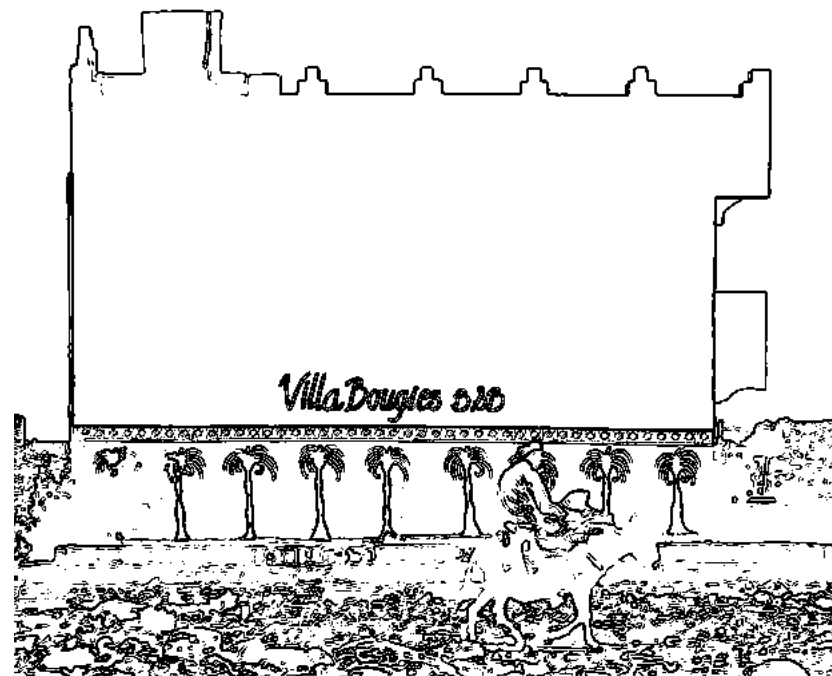
Retouch

Sharpening

Sky segmentation

Contour

Sometimes used internally for
edge enhancement or softening



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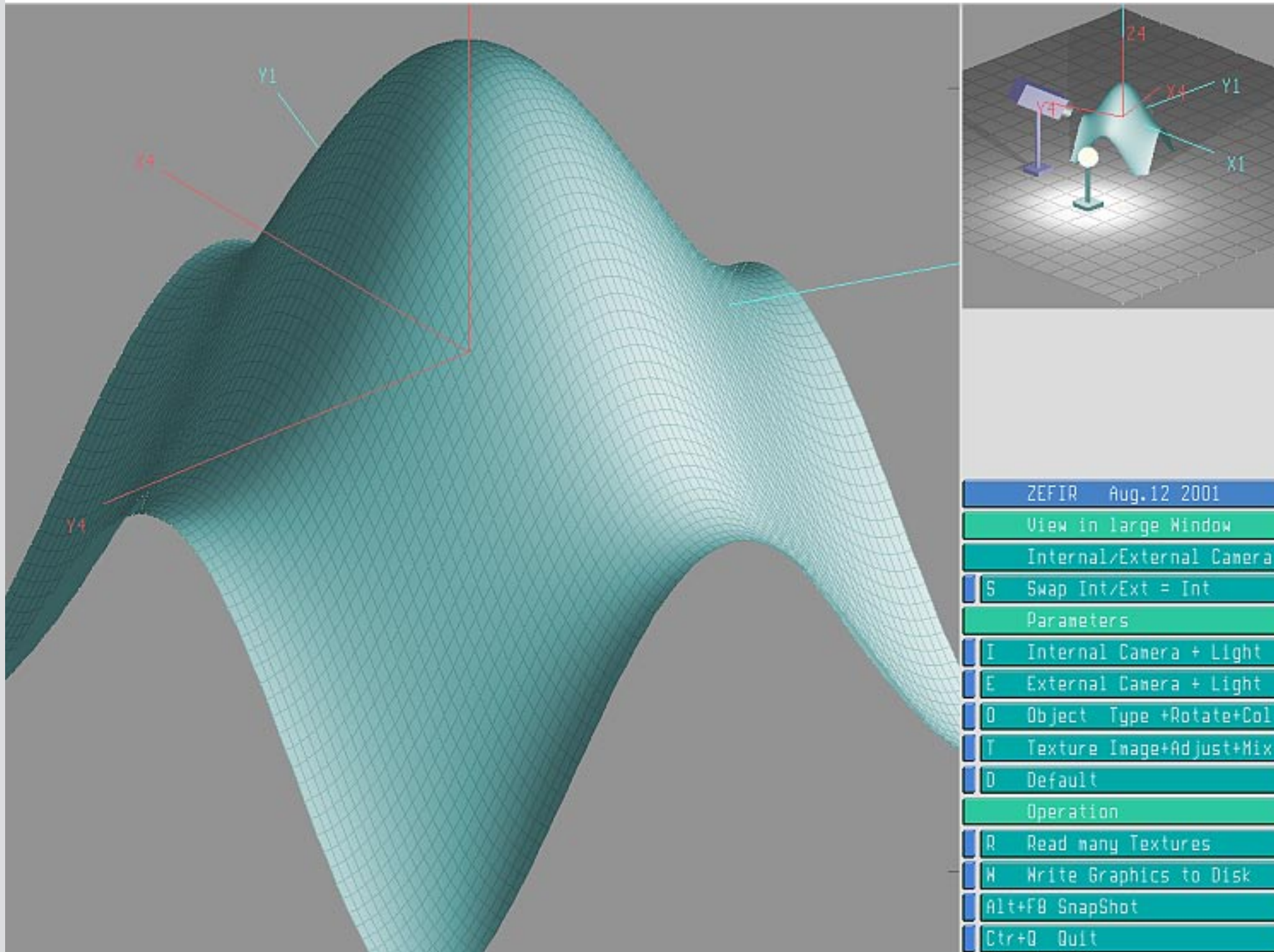
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7 Computer Graphics / Wireframes / Rendering



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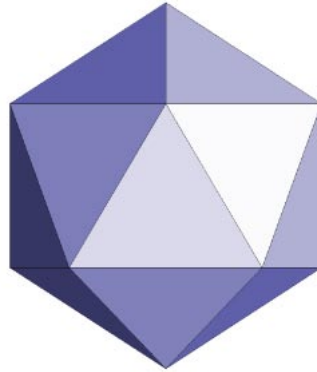
8 Computer Graphics / Textures

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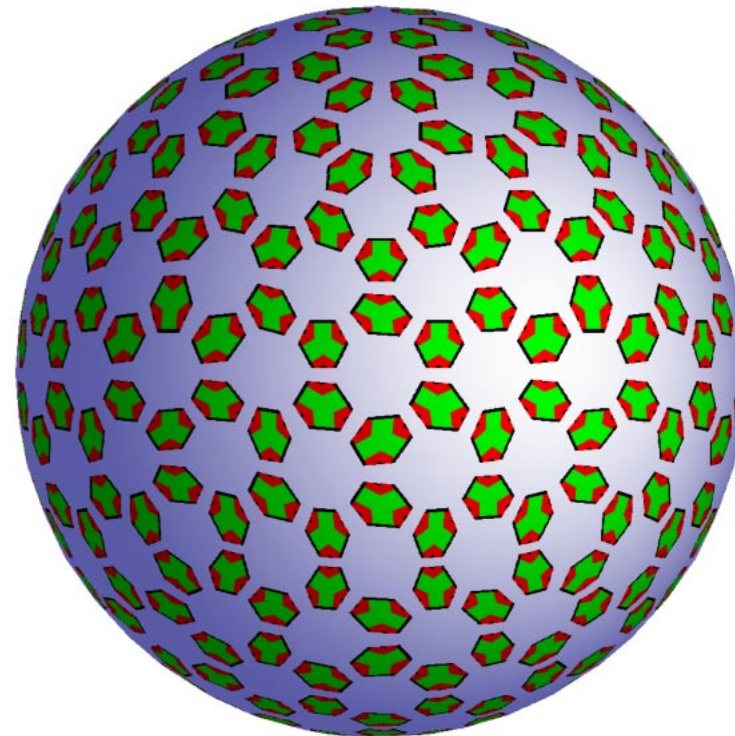
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Subdivided icosahedron
Single icon mapping
Facetted shading



Subdivided icosahedron
Multiple icon mapping
Gouraud shading

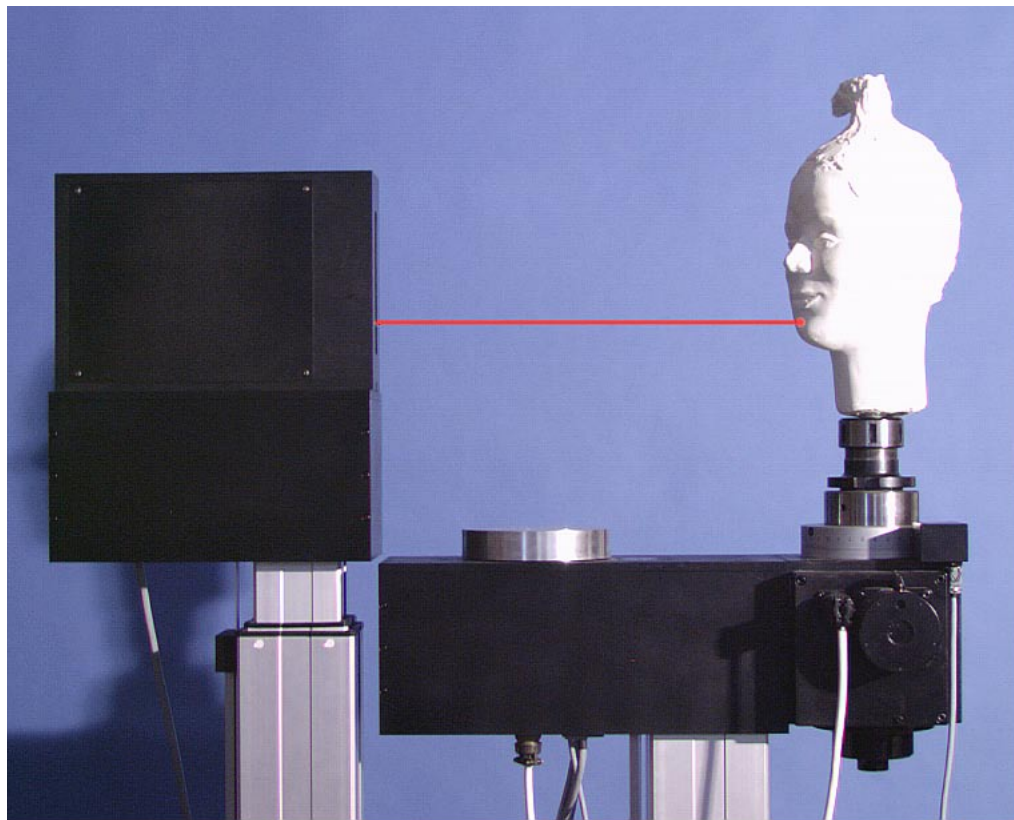


9 3D-Scanning

Our scanner

Turntable and lift

Range by triangulation, using a single row CCD camera



Scanner construction by Toni Gosling



Graphics by ZEFIR

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9 3D-Scanning

Industrial scanner Cyrax 2500

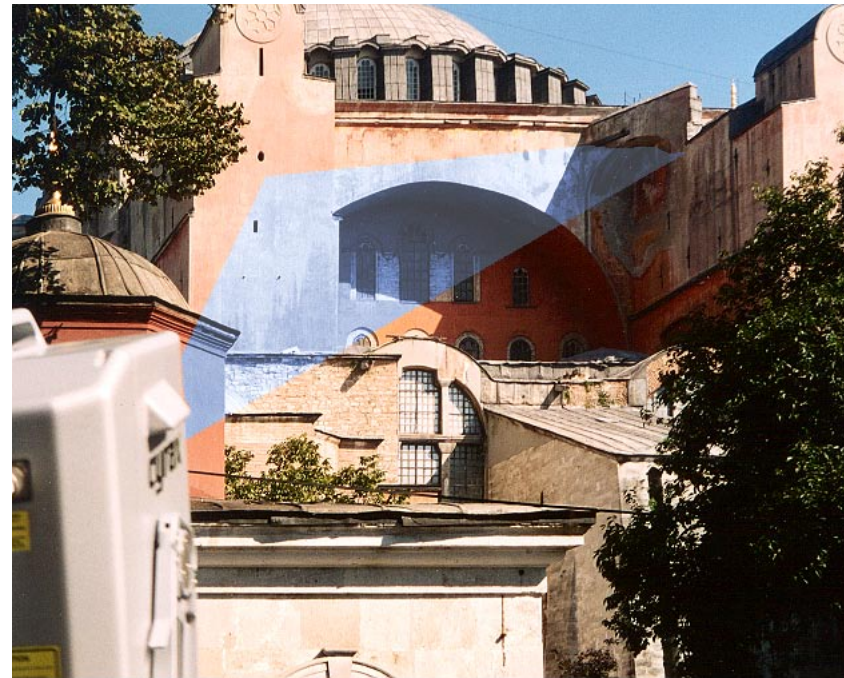
Scanning the Hagia Sophia

A project by Prof.Dr.Volker Hoffmann

Institute for History of Art / University of Bern / Switzerland



Hagia Sophia in Istanbul
Church / Mosque / Museum
Built 532 – 537



Laser beam deflection
by two-axis mirror
Range by light runtime

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10 PostScript Workflow

PostScript is a page description language

A page consists of

- Vector graphics: lines / boxes / curves / circles
- Text: a special kind of vector graphics
- Raster graphics: photos or computer graphics

PostScript guarantees

Consistent workflow between desktop publishing programs PageMaker / InDesign / Quark XPress and printers

PostScript printers

Receive all necessary data for a page

Build the page by an internal high speed processor

Calculate the CMYK color pixels for the printing

Use PostScript PDF for documents

Use PostScript EPS for single pages

Use BMP or TIFF for single raster images



Sir Isaac Newton
1643 - 1717

11 Acknowledgement

Many students contributed to the marionette project

Thanks also to Wilhelm Kettwig, member of the staff

Image Processing system ZEBRA Ralph Scherge

Author

JPEG compression module

H. Hildebrandt

Computer Graphics system ZEFIR Author

Photos

W.Kettwig (8,9)

R.Scherge (14,17)

Author

Sculpture (18) and plaster head M.Hoffmann

Euler / Graßmann / Gauß / Newton Reidt-Wolff



Carl Friedrich
Gauß
1777 - 1855

PDF document composed by PageMaker 6.52 and Acrobat Distiller 5.05

PostScript / PageMaker / InDesign / Acrobat / Photoshop are trademarks
of Adobe Systems Inc.

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May 14 / 2002 — February 23 / 2013

Website

[Load browser / Click here](#)

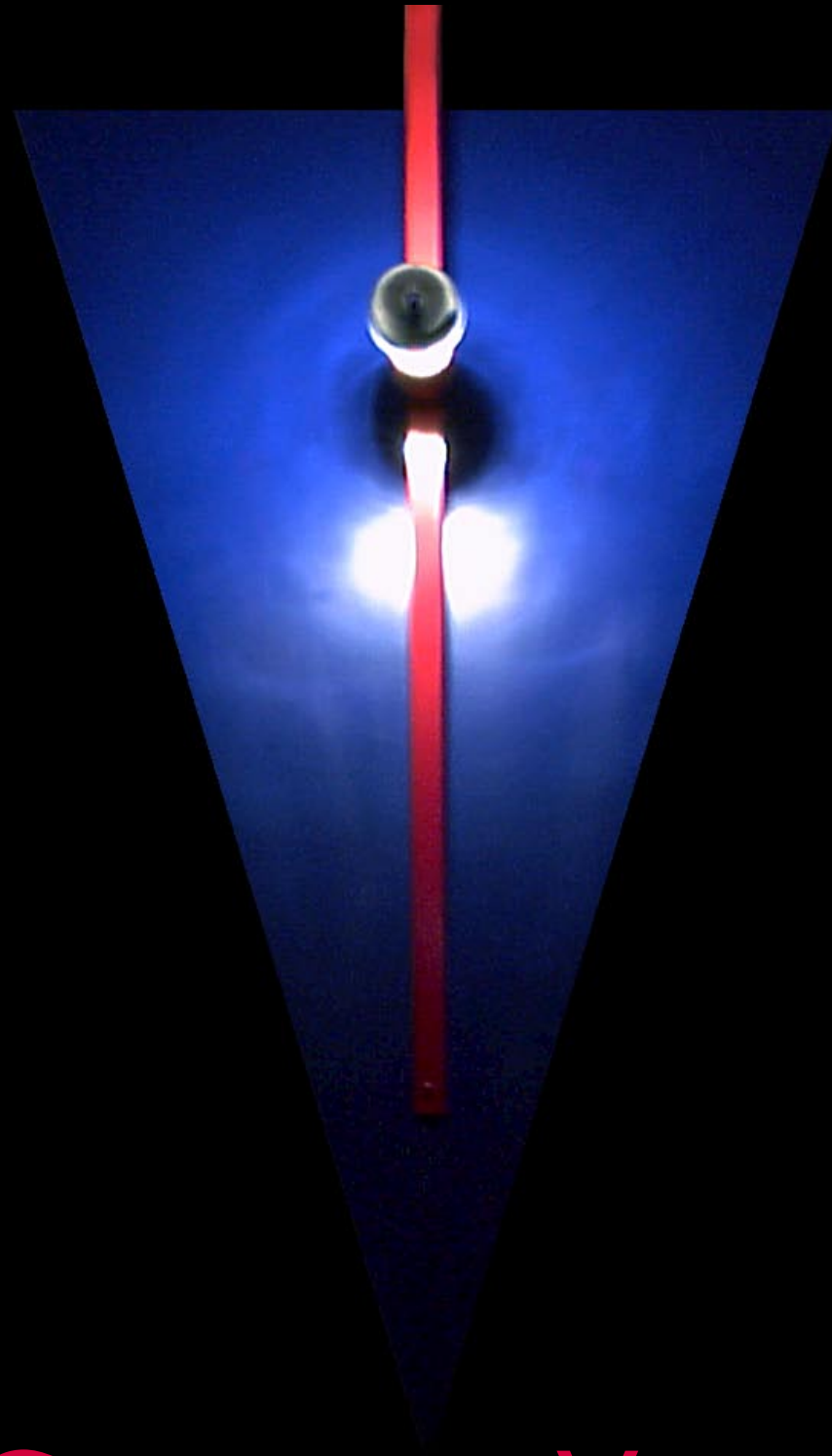
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Computer Vision