Research and Education for Vision and Color Sciences in Chiba University

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Education of Vision and Color

Department of Information and Image Sciences
- Introduction to Visual Information Processing (Prof. Yaguchi)
- Color and Image (Prof. Miyake)
- Psychophysics

Graduate School of Advanced Integration Science
- Visual Science (Prof. Yaguchi)
- Color Reproduction (Prof. Yaguchi)
- Image Evaluation and Analysis (Prof. Miyake)
- Electronic Imaging (Prof. Tominaga)
Current research projects in Yaguchi labo.

- Color discrimination and visual attention
- Mesopic color reproduction
- Color discrimination for color deficiencies and universal color design
- Measurement of contrast sensitivity functions using color images
- Spatiotemporal contrast sensitivity functions and image quality of static images and movies: Motion sharpening
- Color rendering evaluation based on color appearance for solid state light sources
- Visual environment and color perception, etc.
Temporal Characteristics of Color discrimination

Adaptation

Test stimulus

Background color

blue

green

yellow

Cs
Published papers on color discrimination


Color Appearance in Mesopic Vision

Diagram showing the process of color appearance from higher to first stage of luminance channel, red/green channel, and yellow/blue channel leading to color appearance.
Imaging System of Mesopic Color Reproduction

Input: 1000(lx) → Xo, Yo, Zo 

MODEL: LMS → Lum (r/g, y/b) → Xo, Yo, Zo

Output: E(lx) → RGBo, sRGB

(Judd)
Mesopic Color Reproduction
Mesopic Color and Sharpness Reproduction

original 100 lx 10 lx
1 lx 0.1 lx 0.01 lx
Published papers on Color appearance in mesopic vision


Color appearance for dichromats

Normal
Protopanope (missing L-cone)
Deuteranope (missing M-cone)
Tritanope (missing S-cone)
Universal Color Design

Trichromats

Deuteranope

Deuteranope (normal)

(protanope)
Paper on Universal Color Design

Contrast sensitivity functions

A (Luminance)  
T (Red-Green)  
D (Blue-Yellow)

Color translation

A \leftrightarrow L \leftrightarrow X \leftrightarrow Ry \leftrightarrow LutR  
T \leftrightarrow M \leftrightarrow Y \leftrightarrow Gy \leftrightarrow LutG  
D \leftrightarrow S \leftrightarrow Z \leftrightarrow By \leftrightarrow LutB

A grating  
T grating  
D grating
Measurement of contrast sensitivity functions using color image

Original

Opponent-color stage

$F(u,v)$

Filtered
Ex.2 Contrast sensitivity function for ATD filtered image stimuli (Cafe)
Color Vision and Application to Imaging Science

Colorimetric System

- CIE XYZ (1931)
- CIELAB (1976)
- CIECAM02 (2001)
- CIE iCAMxx

Color Vision Model

- L cone
- M cone
- S cone
- achromatic
- r/g
- y/b
- V1, V2, V4, ST, Higher level
- LGN
- Retina
- Rods, cones
- Horizontal cell
- Bipolar cell
- Amacrine cell
- Ganglion cell
- Magno cell
- Parvo cell
- Brain

Application to Imaging

- Spectral sensitivity of image sensor
- Array of image sensors
- Colorimetric color reproduction
- Multi-spectral imaging
- Color difference formula
- Image difference
- Image compression
- Color space for communication
- White balance
- Color reproduction for different image media
- Gamut mapping
- Categorical color reproduction
- Total image quality

To investigate the mechanism of vision
To make a color vision model
To improve colorimetric systems
To apply human color vision modeling systems