A Breadth-First Approach for Teaching Computer Graphics

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Overview

- Teaching Breadth-First
- SIMBA – An educational tool
- Courses “Creativity & Technology”
- Evaluation of course
- Summary
Teaching Breadth-First

- CS Computing Curricula 2001
  - Start with holistic view
  - Use broad approach
  - Undermine with application
  - Then use depth

- Advantages
  - Interdisciplinary teaching, women & men, CS students
Interdisciplinary Teaching in CG

- Computer Graphics for CS and Media Studies
- Computer Graphics for CS and Engineering
- ................
- Computer Graphics for CS and Arts
- ................
- „Creativity and Technology“
  - CS: 2 semester project course (2L+2Se+2Lab + 6Proj)
  - Media Studies: 1 semester (2L+1Lab)
  - Teaching tool: SIMBA
Key Concepts of Computer Science in Multi Media Based Modules

Module for Project
Computer-generated Images

- Computer-generated Color
- Digital Image Processing
- Computer-generated Visualization

- Computer generated Farbe (alt)
- Digitale Bildverarbeitung (alt)

Flyer
Computer-generated Color

- Basics
- Machine Representation of Color
  - RGB Color Model
  - CMY Color Model
  - RGB Color Space
  - CMY Color Space
  - CMYK Space
  - OpenGL Code
- Perceptual Color Spaces
  - RGB ↔ CMY
- Color Coding
  - YIQ
  - YUV
  - YCrCb
- Color Standards
  - Conversion RGB ↔ YCrCb
  - Java code for conversion
- Machine Representation of Images

Overview
- Breadth-First SIMBA
- C & T
- Evaluation
- Summary

UNIVERSITY OF PADERBORN, Computer Graphics, Visualization and Image Processing
G. Domik, F. Götz & M. Schröder  November 30, 2007
Basics

User defined colors

Color

Lite

Hue

Sat

Red

Gre

Blu

20

240

255

128

120

0

Add color

Farben definieren >>

OK

Cancel
Computer-generated Color

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  - Machine Representation of Images
    - Java code for conversion
Experiment by Mathematician Hermann Grassmann, 1853
- Color $\sim a*R + b*G + c*B$ (additive color system)
- R, G, B … primary colors
- a, b, c, … tristimulus values

- metamers
- secondary colors, e.g. Y, M, C
Computer-generated Color

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Perceptual Color Spaces
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  - YUV
  - YCrCb

Color Coding
  - YIQ
  - YUV
  - YCrCb

Color Standards
  - Machine Representation of Images
    - Conversion RGB ↔ YCrCb
      - Java code for conversion

Systematic strategies

Machine Representation of Images

User and Task Mapping

Evaluation Summary
describes reflection of color, as with color printers
primary colors: Cyan, Magenta, Yellow
subtraction of primary colors from white

A note about pigments:
- e.g. water colors contain pigments
- pigments absorb and reflect color
- e.g. blue water color absorbs long and medium $\lambda$, reflects only short $\lambda$.

Absorbing process:

<table>
<thead>
<tr>
<th>CMY Color</th>
<th>Absorbing $\lambda$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>all</td>
</tr>
<tr>
<td>Cyan</td>
<td>long</td>
</tr>
<tr>
<td>Magenta</td>
<td>medium</td>
</tr>
<tr>
<td>Yellow</td>
<td>short</td>
</tr>
</tbody>
</table>
Computer-generated Color

Overview

Basics

Machine Representation of Color

Perceptual Color Spaces

Color Coding

Color Standards

Machine Representation of Images

RGB Color Model

CMY Color Model

RGB ↔ CMY

YIQ

YUV

YCrCb

Conversion RGB ↔ YCrCb

OpenGL Code

Java code for conversion

Machine Representation of Color

Basics

RGB Color Space

CMY Color Space

CMYK Space
- CMY Color space is geometric form of subtractive color model
- Grey values: diagonal white to black
- Unit cube defines color coordinates

**CMY Color Space**

<table>
<thead>
<tr>
<th>C,M,Y</th>
<th>Farbe</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,0,0</td>
<td>Weiß</td>
</tr>
<tr>
<td>0,0,1</td>
<td>Gelb</td>
</tr>
<tr>
<td>0,1,0</td>
<td>Magenta</td>
</tr>
<tr>
<td>0,1,1</td>
<td>Rot</td>
</tr>
<tr>
<td>1,0,0</td>
<td>Cyan</td>
</tr>
<tr>
<td>1,0,1</td>
<td>Grün</td>
</tr>
<tr>
<td>1,1,0</td>
<td>Blau</td>
</tr>
<tr>
<td>1,1,1</td>
<td>Schwarz</td>
</tr>
</tbody>
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Perceptual Color Spaces
- Machine Representation of Images
  - Conversion RGB ↔ YCrCb

Color Coding
- OpenGL Code
- Practice with Color Spaces

Color Standards
- Java code for conversion

Mapping Strategies
- Systematic strategies
- Machine Representation of Images
Breadth and Depth for Visualization

Overview

Introduction to Visualization

User and Task

Mapping

Mapping Strategies

Non-systematic strategies

Systematic strategies

APT

SAGE

BOZ

Natural Scene Paradigm

www.uni-paderborn.de/cs/vis
High-Risers in Valley?
Teaching Creativity and Technology
- Computer Science students side

• Two semester project course
• Prerequisite: Two semesters CG
• First semester
  – Seminar “3D Web Technology”
  – Lectures on Visualization, C&T etc.
  – Project openVisaar (c-s based tool for vis/Java)
• Second semester
  – Project only, pair with media students
Teaching Creativity and Technology - Media Science students side

• One semester course
  – No prerequisites
  – Color
  – Visualization
  – Creativity and Technology

• Lab
  – Maya, Flash, Shockwave
  – Develop effective and expressive visualizations for complex data sets
Teaching Creativity and Technology - Computer Science AND Media students
Evaluation of Tool SIMBA – (by UniDo)

- 84 CS students (70 male, 12 female; 2 unknown)
- 70% approved strongly of the breadth and depth order in the menu
- > 90% : interactive elements helpful to enhance understanding
- 70% found the modules motivational
- 70% declared that application was helpful
Our own question: „What would motivate YOU to learn about color?“

![Bar chart showing the results of the question](chart.png)

<table>
<thead>
<tr>
<th>Absolute Numbers:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Women (17)</strong></td>
</tr>
<tr>
<td><strong>Men (63)</strong></td>
</tr>
</tbody>
</table>

- **Historical Approach**: 23.53%, 15.87%
- **Color Gamut**: 23.53%, 15.87%
- **Webdesign, Homepage**: 17.65%, 14.29%
- **Technology, Hardware**: 29.41%, 11.11%
- **Visualization/Applic.**: 39.68%, 5.88%
- **Other**: 3.17%, 4.17%

- **Women (17)**: 23.53, 23.53, 17.65, 29.41, 39.68
- **Men (63)**: 15.87, 15.87, 14.29, 11.11, 5.88
Conclusions

- Breadth-First approach found useful
- Not easy to develop such tools
Thank you for your attention!