CREATING ELECTRONIC EDUCATIONAL RESOURCES FOR COMPUTER GRAPHICS COURSE USING WOLFRAM TECHNOLOGIES

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Introduction

Improving the efficiency of using information and communication technologies is one of the most important trends in the development of modern education. This work covers recommendations for creating and maintaining interactive electronic educational resources using Wolfram technologies. It contains real-world examples from creating training materials for Computer Graphics course for students majoring in applied informatics. This course provides introduction to computer graphics algorithms, software and hardware, demonstrate awareness of the variety of authoring tools and techniques used in the creation and delivery of interactive multimedia (Elements of Mulitmedia Portfolio); communicate effectively with multimedia professionals about the design, development and delivery of interactive multimedia for educational purposes (Criteria for Educational Multimedia, Elements of Multimedia Portfolio); evaluate the suitability of specific examples of multimedia for educational applications (Criteria for Educational Multimedia, Elements); plan, create and deploy simple examples of interactive multimedia in web browser environments (Elements of Multimedia Portfolio, Flash Portfolio). The peculiarity of this discipline is that each theoretical topic requires illustrations. Wolfram Demonstrations Project ([1]) is the solution to this problem provided by Wolfram *Mathematica* ([2]).

Wolfram Demonstrations Project

The Wolfram Demonstrations Project is hosted by Wolfram Research. Its goal is to demonstrate the possibilities of Wolfram *Mathematica*; to increase the number of Wolfram users; to improve programming techniques; to bring computational exploration to the widest possible audience. Demonstrations Project consists of an organized open-source collection of small interactive programs created by Wolfram *Mathematica*. These programs use dynamic computation to illustrate concepts from a number of fields: science, technology, mathematics, art, finance, etc. The collection covers a variety of levels; from elementary school mathematics to much more advanced topics, including quantum mechanics and models of biological organisms.

Most of the demonstration modules have a straightforward user interface that recomputes plot or virtualization dynamically in response to user actions like moving a slider, clicking a button or dragging one of the graphic elements. Each demonstration also includes a brief description about the concept being shown. All demonstrations run freely on any standard Windows, Mac, or Linux computer using the free Wolfram CDF Player (CDF − Computable Document Format) [3]. It is worth noting that users that use Mathematica 8 or higher can save interactive documents they develop in CDF format. Those documents can be shared and run in free to use CDF Player application, including the ability to embed them as web objects that can be run in any popular browser.

The examples of Wolfram demonstrations used in "Computer Graphics" course

In training process of "Computer Graphics" course we recommend using the following interactive modules:

- Color in computer graphics; additive color systems; subtractive color systems; color space; color cube; intuitive color model; color space conversion.
- Mathematical foundations of the computer graphics; point, vector, distance from a point to a line in two and three dimensional space.
- Coordinate transformations; homogeneous coordinates; transformation matrix; translation, scaling, rotation.
- Graphics pipeline and rasterization. Digital image processing: linear and nonlinear filtering, mathematical morphology, image binarization.

- Image-based rendering and lighting. Illumination models in computer graphics.

Colors and color models are important topics of the computer graphics. The Wolfram Demonstrations Project includes interactive modules that visualize color models and allow performing conversions between them (for example, see [4] and modules: Overlapping Light Colors, Colored Lights, Cartesian Color Coordinate Spaces, HSV Loci in the RGB Color Space, CIE Chromaticity Diagram).

Modules [5, 6] show the examples of using transformation matrices in 2D and 3D: applying transformation matrices to lines, points, figures and rotating about an arbitrary axis. Additionally, we advise using following 2D graphics modules: Understanding 2D Translation, Understanding 2D Shearing, Understanding 2D Rotation, Understanding 2D Reflection, Understanding 2D Rescaling; 3D graphics modules: Understanding 3D Rotation, Understanding 3D Scaling, Understanding 3D Reflection, Understanding 3D Shearing, Orthographic Projection of Parallelepipeds, Cutoff Parallelepipeds, Dissection of a Truncated Octahedron into Hexagonal Skew Prisms and Parallelepipeds.

High degree of students' understanding of rendering algorithms and digital image processing is achieved using modules [7, 8]. For example, using [8], students can to choose filter type (median, maximum, minimum, Kuwahara), and change the size of the convolution matrix. Other modules worse mentioning that cover image processing topic are: Adaptive Thresholding of Images, Filtering Images in the Frequency Domain, Sharpening Images, Image Sharpening, Gaussian Filtering for Blurring, Transformations of Gray Levels in an Image, Image Restoration for Degraded Images, Row Profiles in Color Images, Histogram Threshold by Max Contour Contrast.

We recommend using module [9] when studying the topic "Illumination models in computer graphics". We also recommend: Lighthouses, Gray Color Meditation, Opacity Explorer 3D, Gamma Correction, Optical Model of the Human Eye, Lens Accommodation in the Human Eye.

Conclusion

We reviewed the research carried out in the field of the development of electronic educational resources. A collection of interactive mathematical demonstrations from Wolfram Demonstrations Project covers a big part of the «Computer Graphics» course. Modules from this project allow illustrating the theoretical part of the discipline and give students the opportunity to understand the subject area.

References

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