

Perception and design aspects in computer graphics courses

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Abstract

The importance of perceptual and design aspects for computer graphics courses are discussed. Short modules that could be included in an ordinary computer graphics course are described. They include Introductory examples, The human visual, Preattentive visual detection, Gestalt laws, Bertin's picture theory, Colour, Design rules, Practice, Algorithms, Information on the www and Assignments.

Keywords

Perception, design, computer graphics, teaching.

1. INTRODUCTION

Computer graphics courses traditionally deal mainly with technical aspect of how to generate pictures from geometrical models taking into account time and memory aspects of the algorithms that are used.

The importance of judging the quality of the pictures generated is nowadays more often observed. How should the perceptual aspects of computer graphics be introduced to the students? One possible way of doing that would be to give a course with the same kind of favour as in the book by Ware (2000).

We have however tried to include perceptual aspects into an ordinary course, which to us seems to be the natural way to go. This is certainly what many teachers do at different universities. This paper aims at being a point of departure for a discussion on how to integrate perceptual/design aspects of computer graphics into an ordinary computer graphics (visualization) course.

The paper is organised in sections on each "aspect" that might be included and used during different parts of a course. The time for each module could be 10-30 minutes.

The idea of each aspect is shortly presented together with possible length (in minutes), where in the course it might be included, possible demos and possible papers that might be used as handouts.

At the end of the paper experiences are discussed. Conclusions are also given.

2. INTRODUCTORY EXAMPLES

There are several good examples of how the human visual system helps us to interpret (and misinterpret pictures). When choosing examples it is important to try to use examples both of high level features as well as low level features. Below we give a few examples that we used.

- Light from above: the shading of surfaces helps the human visual system to interpret the shape of objects. This interpretation assumes that light comes from above and if pictures are turned upside down the appearance of the shapes may change.

- Right angles: a room without right angles might be interpreted as having right angles giving wrong interpretation of the size of objects.

- Kanizsa Illusion: three sectors of circles are organised in a way to give the illusion of a triangle which does not exist.

- Ponzo illusion: two horizontal lines of equal length above each other are viewed together with two almost vertical lines but with a slope making them cross each other above the picture. The horizontal lines are perceived to have different length.

- Hermann Grid Illusion: a rectangular pattern with dark squares separated by white lines. Black dots will appear at the crossings of the white lines. This illusion is also rather easy to explain, which suitable for a course.

- Simultaneous Contrast: dots of equal intensity and colour are drawn with different backgrounds. The background will influence the perceived intensity and also the colour.

3. THE HUMAN VISUAL SYSTEM AND ITS LIMITATIONS

Knowledge of the fundamentals of the human visual system (HVS) is important. Fewerda (2001) gives a good introduction to the properties and limitations to the HVS with information on different parts (from the retina to the visual cortex). It is important for the students to understand that processing will occur at a low level with frequency and intensity limitations as well as at a high level with interpretation of shadows, shades, projections etcetera.

4. PREATTENTIVE VISUAL DETECTION

Visual properties that exist in a picture, for instance in visualization, may sometimes be detected directly (preattentively) and sometimes they have to be searched for sequentially. Healey (2002) has presented good examples in a SIGGRAPH tutorial as well as on web. He also gives a list of some of the visual features that have been identified as preattentive.

5. GESTALT LAWS

The Gestalt psychologists have identified rules for how a human interprets pictures using proximity, similarity, closure, good continuation etcetera. It is valuable to show the students that theories that are approximately one hundred years old still are of interest for the computer graphics.

6. BERTIN'S PICTURE THEORY

Bertin (1967, 1983) has developed a theory with visual variables for visualization. Some of the ideas has later been used in systems like Spotfire. We think that it is a good idea to present Bertin's visual alphabet in a graphics course to introduce the possibilities graphics presentations.

7. COLOUR

Except for fundamental colour theory including colour models it is natural to include additional material such as perceptual uniform colour models and different colour space distances. Special color effects that could be discussed such as the influence of different backgrounds as well as the fact that the perceived size and depth of an object is influenced by its color.

Colour scales are important for visualization and examples can be given with spectrum color scale, double ended color scales, intensity scales, color saturation scales, striped color scales etcetera.

Design rules for colour in computer graphics are important. A good discussion is given by Foley et al. (1990). It is easy to find examples of bad colour design from www. The students can be asked to find them.

8. DESIGN RULES

Design rules are easier to set up when dealing with a specific application. One such application is diagram drawing, where explicit guide lines exist regarding the amount of information and how the scales should be chosen etcetera. Paller et al. (1981) give a list of "poor" and "better" examples. Tufte (1983) discuss more general principles on the subject.

9. PRACTICE

Visual thinking is important for computer graphics people. Parslow (1991) has given introductory examples that can used to test the ability of 3D thinking. He used simple 3D objects such as a cube and its relation to 2D shapes.

Another piece of practice is to ask the students to make actual drawings with pen and paper. Using a designer or an artist the students can be asked to illustrate some simple facts (we used the number of different flowers bought by families before christmas). The students are then asked to show their pictures which could be discussed with the designer/artist.

10. ALGORITHMS USING KNOWLEDGE ON THE HVS

During the last few years we have seen graphics algorithms and systems that take advantage of the limitations of the HVS in order to avoid calculations of details that are not perceived by the viewer. McNamara (2001) gives a good introduction to some of these possibilities.

11. INFORMATION ON THE WWW

There are several examples illustrating perceptual aspects available on the web. Kaiser (2002) gives a good overview with several examples and also some theoretical explanations. The students can be asked to search on www for information and examples starting with some good examples from the teacher.

12. ASSIGNMENTS IN A COURSE

Assignments that include perception and design in computer graphics courses can be used in different ways. We give a few alternatives of which some have been mentioned above:

- an ordinary graphics assignment made by a student could be discussed with questions on the quality of the picture result from a viewer's point of view.
- an interface of a system could be evaluated by the students and discussed in groups together with a teacher
- a sketch of a picture could be drawn with pen and paper before the actual computer work in order to separate the design work from the implementation work. The result at the end can be compared with the sketch.

13. DISCUSSION AND CONCLUSIONS

The different aspects that have been presented above represent some possibilities on how one can introduce perception and to some extent design in computer graphics courses. The aim of this paper has not been to give an outline of a course on perceptual computer graphics. Such a course would require more theory to give a deeper understanding of the principles and concepts.

Here we have instead tried to present how perceptual aspects could be introduced within the limits given by an ordinary computer graphics course using small teaching modules.

We think that it is of value to show that graphics in this context is interdisciplinary. We try to use knowledge from different fields, such as perception researchers using psychophysical methods, neuroscientist, artificial network researchers, vision researchers, graphics and visualization researchers, graphics designers, artists, photographers, users etcetera.

Horton (1995) gives a list of possible blunders that a designer may be involved in. The examples deal with cultural differences, i.e. we interpret images differently depending on our background related to gestures, icons and color. Other examples are related to resolution and to integrated organisation of text and images.

Perceptual aspects of computer graphics is important for the evaluation of the final result from computer graphics systems. Students should in the first courses be aware of

this fact and therefore get a short introduction to those concepts as a part of computer graphics courses.

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