Informatics

Informatics Department Demonstration Handout

Colour Information

1 Colour

Colour is determined by the spectral distribution intensity of visual radiation. The spatial distribution of the radiation sources may also be a factor. For example, "fake" colours are produced by patterns of moving black and white lines. Indeed, all the colours on a colour television are produced by only three monochromatic phosphors. Here, the phosphor dots are so closely intermingled that the visual system is fooled into adding together the separate colours . It is fortunate that the mapping from spectral distribution to perceived colour is injective i.e. many physical colours will map to the same physiological colour. In this way, a television monitor can simulate a wide sub-range of colours without necessarily matching their spectral distribution.

What is clear, is that colour perception is a complex phenomenon and very much an artifact of high-level visual processing. Both physiological and psychological mechanisms are involved.

Colours may be represented by a number of models. Some of these models reflect the method by which a particular technology reproduces colours (e.g. colour printing or VDU technology). Others correspond to the more intuitive artist's notions of colour, hue and shade. In fact, our own experience with *red* (a colour editor, see later) has shown that these artist's models are the easiest to interact with, and so tend to be the most useful.

A model which encompasses ALL light sensations we experience with our eyes is the Commission Internationale L'Eclairage (CIE) model. This forms an international standard and specifies all colours in terms of three distinct primaries. The whole range of colours covered by the CIE model, cannot be displayed by any current technology.

Any model used in computer graphics must ultimately be mapped to the representation that the output device employs, which in many instances is a description in terms of red, green and blue components. Therefore, there must be mathematical transformations to change between the numeric representations for the different colour models. Indeed, it is often such a transformation that defines a particular colour model in terms of another. All the models used by *red* are defined in terms of red, green and blue components.

2 Definitions

- Hue

  Intuitive or empirical measure of quality of colour information. This will answer the question "Is it purple, yellow etc?".

- Saturation

  Intuitive or empirical measure of quantity of colour information. This measures how far the colour is from being achromatic or grey. It will answer the question "How strong a red is it?".

- Value and Lightness

  Empirical measures of how dark or light the colour is.

2.1 Colour Models

Most colours models represent colours as a volume in "colour space". Any particular colour is represented as a point within this volume and is specified by three coordinates. A number of common colour models are described below. The names of these models are formed by concatenating the standard variable names used to represent the three coordinates.

- RGB

  Colour specified in terms of its red, green and blue components (the additive primaries). This is the form of colour information that a colour monitor understands.

- CMY

  Colour specified in terms of its cyan, magenta and yellow components (the subtractive primaries). This is the form of colour information that a hard copy device and some artists understand.

- YIQ

  This is the form of information that an American colour television understands. The Y-component alone is the information that a black and white television understands, giving an indication of how the image will appear in monochrome.

- HSL

  Colour specified in terms of its hue, saturation and lightness: the lower the value of lightness the nearer the colour is to black; the higher the lightness the nearer the colour is to white; for extreme values of lightness the hue and saturation have little effect on colour. Primaries and secondaries all have the same lightness, which is half that of white in this model.

- HSV

  Colour specified in terms of its hue, saturation and value. The value is related to lightness, as above, but the primaries and secondaries have the same value as white (and each other).

3 Red, a Colour Editor

Red is an interactive graphical colour editor. Frequently, to specify a colour for computer graphics you must supply the red, green and blue components (as three numbers from 0 to 255 inclusive). Choosing a colour is thus an iterative procedure involving first specifying the numbers, and then visually inspecting the results. A problem with this is that humans do not naturally think of colours in terms of numbers. It is not intuitively obvious how one should change the numbers of the currently visible colour to those of the desired colour.

Red attempts to circumvent these problems by presenting an easy to use *what you see is what you get* (WYSIWYG) interface, that allows colours to be chosen visually, without recourse to an intermediate numeric representation. *Red* supports all the colour models described above.

A typical display for a colour workstation will have the ability to display on screen 256 different colours simultaneously. However, each of these colours can be chosen from a much larger set of colours, usually 16,777,216 (i.e. 2 ^ 24). A set of colours chosen for on-screen use is called a colour map.

To display a blue vase with as smooth shading as possible clearly requires a large proportion of the colour map to be devoted to shades of blue.

A colour map gives the advantage of being able to display any desired colour, despite the limitations on the total number of colours. Set against this, is the problem of resource contention which could arise if a smoothly shaded blue vase was to be displayed simultaneously with a smoothly shaded red vase.

A colour map can be regarded as a look-up table that determines the mapping between colour number (0 to 255) and visual appearance (red, green and blue components from 0 to 255). Skillful use of colour maps can provide many special effects such as transparency, animation and control over graphical object visibility.

Red allows colour maps to be manipulated as units. For example storing a colour map in a file, will allow another application to subsequently use this set of colours.

4 Colour exercises

It will be possible to use *red* and gain experience of different colour models. There will also be an opportunity to match a given colour by adjusting the colour model components

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