Tonal Description Of Colours for the Visually Impaired

The aim of the work outlined in this communication, is to investigate ways to convert colour visual information into auditory outputs. The objective of this research is to work towards the development of systems that could be used to aid the blind and partially sighted. Many of the techniques used in the development of industrial vision systems may be useful in the initial development and promotion of research in this area. It should be emphasised that this work is not intended to offer the possibility of perfect sensory substitution to those who are visually impaired. To do so would be both misleading and unfair. This is a first tentative step into a research area prone to the danger of unduly optimistic expectations.

Design description

The basic premise of the system is to exploit the similarities of structure between colour and sound. Colour has a cycle of hues, while sound has a cycle of tones in an octave. Colours are arranged into levels of saturation while tones are grouped into octaves. Figure 1 illustrates the colour description system incorporating a high speed look up table (LUT)[1] and a sound synthesiser. As well as transforming the 18-bit Red-Green-Blue (RGB) values from a colour camera, to 8-bit hue and saturation (HS) values, the LUT enables real time colour segmentation and recognition (see Molloy[2], Batchelor and Whelan[3] for more details on how this is implemented).

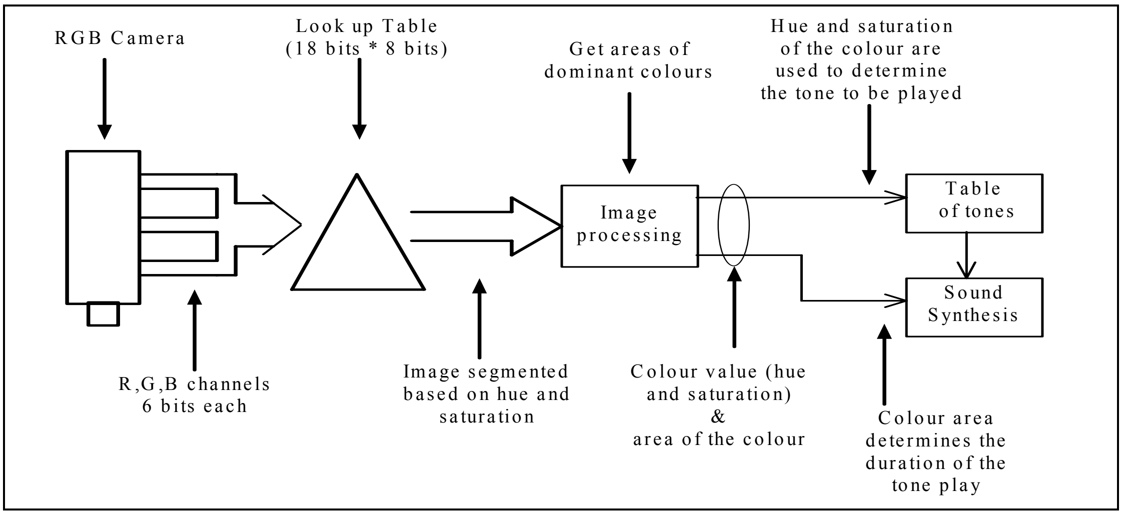

Figure 1. Operation of the colour-to-tone converter

Programming the LUT consists of generating patterns in the colour triangle (a 2-dimensional slice through the RGB colour cube) that can then be projected throughout the complete LUT. To distinguish the hue and saturation of colours, a pattern is generated so that each region in the triangle has a distinct intensity. Colours of varying hue and saturation can then be distinguished by thresholding the image that has passed through the LUT. Colour triangle segmentation was implemented so that in the mapping of hue to single tones, the four colours (red, green yellow and blue) are spaced at every third semitone. The area allocated to each hue is not constant. The duration of the tone is determined by the area associated which each colour. The sound synthesiser can play several tones at various levels and frequencies concurrently. For the current experiments however, the four dominant colours in a scene are selected and their corresponding tones played.

Trials of the system have shown that a means of distinguishing between colours has been provided. It still remains to be examined if the system is successful at providing adequate distinction on complex colour scenes. In generating auditory analogues of the visual world there are a great multiplicity and complexity of mappings that can be used to generate auditory displays. By exploiting new techniques in this area it may be possible to provide improved auditory representation of a colour scene.

References

1. A.P. Plummer (1991) "Inspecting coloured objects using grey scale vision systems", in *Machine Vision Systems Integration,* Proc. SPIE **CR36,** Boston, pp 78-92.
2. D. Molloy, T. McGowan, K. Clarke, C. McCorkell and P.F. Whelan (1994), "Application of machine vision technology to the development of aids for the visually impaired", in *Machine Vision Applications, Architectures, and Systems Integration III*, Proc. SPIE **2347,** Boston, pp 59-69.
3. B.G. Batchelor and P.F. Whelan (1994), "Fast color recognition technique for inspection and robotics", in *Applications of Digital Image Processing XVII*, Proc. SPIE **2298**, San Diego.

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Legend:

Figure 1. Operation of the colour-to-tone converter