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TECHNICAL REPORT

A FRAMEWORK FOR THE MEASUREMENT OF VISUAL APPEARANCE

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FOREWORD

This report was prepared by CIE Technical Committee TC-1.65 "Visual Appearance Measurement" of CIE Division 1 "Vision and Colour". Members of the Technical Committee during the preparation of the report were:

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A FRAMEWORK FOR THE MEASUREMENT OF VISUAL APPEARANCE

SUMMARY

Visual appearance can be one of the most critical parameters affecting customer choice and it needs, therefore, to be quantifiable to ensure uniformity and reproducibility. A starting point in assessing the appearance of a consumer product might be the measurement of its colour. A description of its total appearance, however, cannot be achieved by the definition of colour alone; other attributes of the material from which it is fabricated contribute to the overall appearance.

Starting from a definition of soft metrology and a description of measurement scales, this report describes a framework on which a set of measurements could be made to provide correlates of visual appearance. It will be shown that the interactions between the various components of the framework are complex, that physical parameters relating to objects are influenced, at the perception stage, by the physiological response of the human visual system and, in addition by the psychological aspects of human learning, pattern, culture and tradition.

The result might be to conclude that an attempt to measure appearance may be too bold a step to take. Thus, a sub-framework is considered in terms of what can now be measured, and what might be measured after further investigation and research. By dealing with the optical properties of materials it is seen that there are, perhaps, four headings under which possible measures might be made: colour, gloss, translucency and texture. It is recognised that these measures are not necessarily independent; colour may influence gloss, colour will certainly influence translucency, and texture is probably a function of all three of the other measures.

Colour measurement, colorimetry, is based on the measurement of spectral reflectance, and is an established science that is possible using commercial instrumentation available at reasonable cost. Two shortcomings are identified. First, there are a number of modern materials where colour measurements made using a single pair of illumination/viewing angles is not sufficient to describe the perceived colorimetric effect. Thus, measurement at more illumination/viewing angle combinations is required. Second, the traditional, CIE recommended colorimetric parameters, while providing correlates of visual percepts, are not able to predict the absolute appearance of a coloured sample: colour appearance models are now able to do this.

The measurement of gloss is an established methodology but there is some doubt as to the scientific basis for making the measurements using the present method and attempts are being made to define alternative approaches. The extension of gloss measurement, which is essentially a measurement made at a specific angle depending on the apparent gloss of the sample, to investigate the shape of the gloss peak, should provide more information.

Translucency is a subjective term that relates to a scale of values going from total opacity to total transparency. This whole subject area needs investigation to find a rigorous measurement solution that will probably be industry specific.

Texture is a harder variable to measure. The advent of digital imaging systems makes the acquisition of images of materials relatively easy, assuming due consideration is given to the resolution of the image capturing device, be it a camera or a scanner. Characterising these images to give accurate CIE based colorimetry is now possible and the application of suitable analysis software should be able to provide measurement scales that relate to the perceived texture. The idea of establishing a series of 'standard' textures has been suggested.

French summary
This can come later.

German summary
This can come later.

of light may be compared by visual assessment, but it is common to use a filtered photo-detector whose spectral response approximates to that of the human eye. In colorimetry, the amount of light reflected from, or transmitted by, a stimulus can be detected using three photo-detectors whose individual spectral response approximates to the colour responses of the human eye[40].

These measurements can also be made spectrally by measuring the amounts of radiation using narrow bands of wavelengths situated at regular intervals throughout the spectrum. The photometric and colorimetric parameters are then calculated using tables of data corresponding to the appropriate spectral responses.

Thus, the human perceptual attribute, the 'colour', of a sample can be 'measured' in terms of the response of the CIE standard observer using a CIE illuminant and its position relative to any other colour located on a colour map. This type of measurement is important, for example, in assessing whether the colour of a signal light is appropriate. To be correct, the measured colour must fall within a defined area on the colour map, and this area is usually specified by an appropriate standard. There should be no overlap between the areas designated for different coloured signals to avoid confusion to the observer. An application is in railway signalling where red signals from different manufacturers may appear to have a slightly different colour but their measured colours must all fall within the designated area of the colour map. Thus, to the train driver they should all appear 'red'[41].

In industry, often the relative 'colour-difference' between a reference sample and a test sample is more important than absolute colour. In the clothing industry, for example, a cloth sample swatch might be provided for a dye-house to formulate a recipe and dye a sample to match. While an instrument can measure the colour of both pieces of fabric in an absolute sense, it can also calculate the colour-difference between them, on a scale that correlates with the colour difference perceived by a human observer.

3.2 Cesia

In 1991, Caivano has published several papers describing his concept of *cesia*, which he describes as the psychophysical evaluation of different modes of appearance[42,43,44,45,46,47,48]. Cesia recognises four elements of an object that are similar to those described above and to be elaborated on in this report: colour, gloss, translucency and surface texture. The proposal is interesting in that it attempts to embrace the concept of 'total appearance', but confusing in that it recommends the use of scales that mix various aspects of perception. For example, the 'matt white – matt black' scale mixes two basic perceptions, *i.e.* matt (a gloss term) and black/white (a colour term). In addition, the 'specular – transparent' scale mixes a gloss term (specular) and a translucency term (transparent). This mixing of perceptual terms for the scales defined by the concept means that their measurement would be difficult. Thus, while the concept of cesia is recognised as contributing to the very complex subject of total appearance, it is not obvious how it contributes to the measurement of appearance.

In the following sections of this report, each of the four separate groups: colour, gloss, translucency and surface texture will be discussed in more detail. The present knowledge of how they can be measured will be described, together with an indication as to how improved measurement can contribute to understanding the way in which visual appearance might be 'measured'.

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