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Abstracts
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Eyeing the Camera

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Imaging systems are compared to the eye in terms of acquisition, spectral sensitivity, transmission, and display. Although the performance of imaging systems is generally of a high standard, if the goal is WYSYWYG, what you see is what you get, there is still room for improvement. At the acquisition stage, the use of flash, or infra-red lighting, results in images with some unnatural features, and there is a general absence of systems that give monochrome images at very low light levels, as are provided by the rod system in the eye. The overlapping nature of the spectral sensitivities of the cones results in unwanted cone stimulations which reduce reproduction gamuts; in printing, extra colorants, such as orange, green, and violet, can be used to extend the gamut and reduce metamerism. Commercially available imaging systems incorporate spectral sensitivities that do not usually exactly match a set of color matching functions, which is a requirement for special applications where high colour accuracy is important. The transmission of image signals in broadcast television makes use of the important luminance/chrominance principle, but full benefit is not achieved because of gamma correction, and only one system makes use of the reduced resolution of the yellowness-blueness channel of the eye. Successful bit reduction in digital images is achieved by taking advantage of the reduced contrast sensitivity of the eye at high spatial frequencies and other effects, but a reduction in the consequent artefacts is desirable. In the visual system, the display is in the cortex, which has an enormous ability to interpret the retinal signals so as to recognise objects; automatic image-enhancement adjustments can be included when making images, but there is room for more sophisticated techniques that avoid impairing some types of scene. A low-cost display device for the mass market that is more convenient than the cathode-ray tube remains an important challenge.

The Measurement of Appearance

Dr Michael R Pointer,
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The visual appearance can be one of the most critical parameters affecting customer choice and, therefore, it needs 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. The 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. The texture of a surface, for example, will cause changes in colour depending on the lighting direction; the freshness of food is judged by its overall appearance, but in a way that is much more subtle than by just its colour; and novel effects such as pearlescence are added to products to enhance their attractiveness. For some products, such as cosmetics, it is not only their own appearance characteristics that are important, but also the visual effect after they have been applied to the skin, nails, hair, etc. It is clear, therefore, that the interest of industry in the measurement of appearance goes beyond simply surface colour. This presentation will discuss the appearance measurement project at NPL with special reference to the use of digital imaging techniques.

Pitfalls in the Colorimetry of Hard Copy Images

Professor Geoffrey Attridge
Imaging Technology Research Group, University of Westminster

The colorimetry of hard copy images is of interest in a number of fields of technical activity. The success and usefulness of such colorimetry are critically dependent on the instrumentation available and structural features of the image. Examples of colorimetric and sensitometric equipment are discussed in terms of their advantages and limitations in the study of hard copy images, and the accuracy achievable in each case. Where possible, calibration procedures are recommended in order to optimise the use of such equipment. Typical gains in accuracy through optimisation are quantified in terms of CIELAB colour differences.

Image Quality Measurements: What Now? What Next?

Professor Ralph Jacobson
Imaging Technology Research Group, University of Westminster

Definitions of image quality are given and distinctions made between image quality metrics and visual image quality metrics. From these definitions a critical appraisal of image quality metrics, their evaluation and application follows. Although Image quality metrics of varying types have been used for many years and have been applied successfully to the improvement of imaging systems, they do have a number of limitations. Using examples from both analogue and digital systems the single number visual image quality metric approach is critically reviewed. The validity of the direct transfer of those metrics, originally devised for analogue systems in to the digital domain is questioned. Spatial and, colour aspects are considered independently as are metrics that combine colour and spatial aspects. Attention is also focused on complications associated with scene content and to some more recent considerations of attributes such as 'naturalness' and 'fitness for purpose'.

Assessing the Capabilities of Digital Imaging Satellites

Grant Thomson
Strutt and Thomson

Any assessment of a satellite-based imaging system needs to consider aspects of image quality, and coverage of the terrain below, in terms that [to a large extent] will be dictated by the satellite's orbital characteristics. Some of the implications involved by this are discussed.

The Past, Present and Future of Quantification in Infra red Thermal Images

Professor Francis J Ring and Professor Kurt Ammer
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Thermal imaging systems became available for non military applications in 1960, and were primarily designed for visual presentation of temperature. In medicine, where temperature measurement in man had established itself for diagnosis of fever, images of the body surface were an entirely new concept. The first British IR scanner Smith's Pyroscan, did not have a direct display, and required from 2-5 minutes to show the image on electrosensitive (Mufax) paper. A bank of thermal references was made to be imaged in the picture, so that densitometric analysis could be used on the printed image. By 1965 oscilloscope displays had been introduced, and bright-line "isotherms" provided a more graphic indication of temperature. The monochrome display limited the use of these isotherms, so a false-colour technique based on multiple exposures through filters to a single frame was developed. These first colour thermograms gave a two dimensional image of temperature distribution. In 1972 in Bath we obtained the fist computer for image processing based on a pdp8 with a colour monitor. This enabled us to develop a thermal index as a means of assessing arthritis and its response to drug treatment.

With advanced current technology we now know more about the selection of regions of interest, and the many parameters required to establish a standard protocol required buy the international medical community. Current projects are underway to create a normal image database that can in future be referenced on-line in any part of the world. By the use of special file transfer formats, this database will be added to by other thermal imaging centres using different IR cameras and software, but to the agreed standard technique. It is hope that much of the uncertainty and slow learning of thermal image patterns in health and disease will be changed by this initiative. There are currently centres in Vienna, Warsaw, Lodz and Glamorgan working together, with other partners to be added as the project is further developed.

A Method to Reduce the Variation in Moment Invariants due to Changes in Image Contrast

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Moment Invariants have been explored in many fields to classify objects. Developed by Hu the technique is invariant to changes in scale, translation and rotation of the object to be identified. Changes in target contrast, however, cause increased variation in calculated invariants and thus lighting and exposure conditions greatly affect the outcome of the processing. It is therefore common practice to calculate moment invariants only after binary segmentation of an image has occurred. This causes potentially valuable information held by the grey level distribution in the target to be lost.

A technique is described which aims to reduce the sensitivity of Moment Invariants to changes in contrast. This technique is compared to that described by Maitra. The technique is further enhanced by modification of the dynamic range of each of the moment invariants calculated to normalise their contribution to classification of the object. Principle component and discriminant analysis was applied to optimise the decision making process. Results of experimentation using the above techniques show it to be robust to changes in contrast and are presented.

Quantification and Assessment of Retinal Images of Infants

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A new generation of retinal imaging cameras for use on premature infants, which are capable of achieving a much larger field of view than previous systems, are starting to become available for use in hospitals. In premature infants, the new cameras are able to track the progression of the sight threatening condition, retinopathy of prematurity (or ROP). ROP is a major cause of preventable childhood blindness. It is a condition where the process of retinal vessel growth is disrupted by pre-term birth. Work on image analysis techniques to assess and quantify features on images taken with the new generation camera systems is described