Hyperspectral imaging and image interpretation

Colour is an important diagnostic sign: animals judge the ripeness of a fruit from its colour; the temperature of a star can be gauged from its hue. Colour is also an important sign in clinical diagnosis. Our work has shown that through the understanding of the image formation process it is possible to derive information about the internal structure and composition of objects and tissues from their colour images.

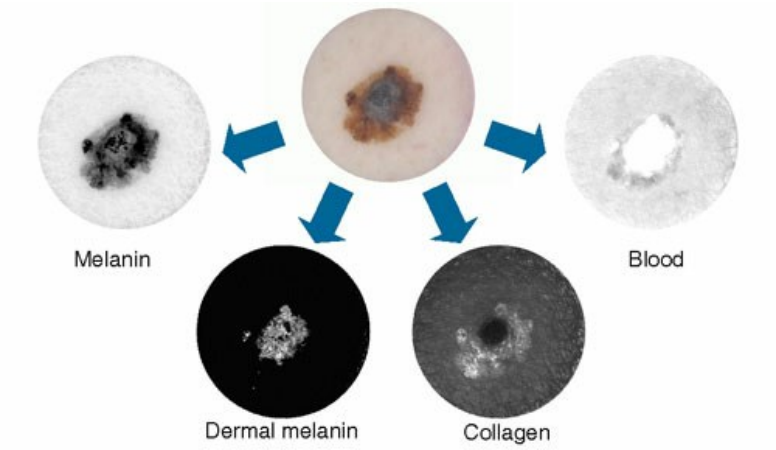
How do the colours that we see on a surface arise? Light emitted by a source interacts with the surface and the interior of an object and through these interactions, mainly absorption and scatter, the spectral composition of the light is altered. The changes reflect the structure and optical properties of the materials constituting the object and in this sense the light remitted from the object "encodes" its properties. Our group has succeeded in partially deciphering this encoded data, so that we can deduce some aspects of the structure and composition of object from its colour. At the heart of our method is an abstract model of object colouration, which provides a cross-reference between the object composition and its colour, or some richer spectral characterisation. As the model is constructed using physics, the physical origin of colours seen in images can be explained with reference to the actual physical phenomena.

The practical significance of the method is that for suitable classes of materials, quantitative estimates of their composition can be obtained from their image data and presented in the form of parametric maps. The underlying scientific technique is fundamentally generic and is the basis of a unique non-destructive testing technology which does not require complex equipment and could be implemented using only a digital camera with filters and analysis software. The method has been successfully applied in a number of domains including:

- skin imaging for the diagnosis of skin cancers
- early detection of diabetic retinopathies from fundus images
- FRET detection in the studies of protein interactions using fluorescence microscopy
- mapping the physical properties of cosmic hot gas X-ray hyper-spectral images

This work is interdisciplinary, it draws ideas from physics, chemistry, applied mathematics, computer science and visual perception. Together, these ideas expand the boundaries of what is currently possible through image interpretation.

Parametric maps showing histological features of an advanced melanoma



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