Colour and Space in Cultural Heritage - Cost Action TD1201

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Proposal for an oral presentation (15 min)

Colour and Scale: Colour Measurement on Small and Large Museum Objects

Different techniques can be used to measure the colour of object surfaces. Depending on the size and shape of the objects or the aim of the study a suitable technique is chosen accordingly. The purpose of the study was to evaluate the level of agreement among different techniques, both ISO standard conform or not. Depending on the type of study carried out, a certain level of agreement between two measurements (precision) or between two techniques (accuracy) is required for colour measurements. The colour measurement comprises the evaluation of the spectroscopic characteristics of the sample surface in the visual range. But colour perceived by a human eye is not alone a surface characteristic: Next to incident light which is scattered or absorbed at a surface colour perception is influenced by the characteristics of the perceiving eye and colour processing in the brain.

The ISO standard conform methods used in this study should be able to measure the colour with high accuracy. They use an internal light source and a so-called integrating sphere to capture all diffuse scattered light from the sample surface. The spectrometers Spectro-Color (Dr. Lange) and CM 2600d (Konica Minolta) were tested. These devices evaluate a maximum circular spot of a diameter of 10 mm or 8 mm (adjustable), respectively. Ideally the surface in this area should be homogeneous, smooth and flat. The surfaces of museums objects are mostly structured and heterogeneous in colour. In such cases and for the study of remains of paint layers the colour measurement of smaller areas would be advantageous. The coupling of a microscope with a VIS-spectrometer enables this application (Zeiss Discovery V8 Binokular with Zeiss PDA VIS Spectrometer MCS621 VIS II, coupling by AS&Co). Another technique to evaluate the colour properties is digital imaging. This technique is convenient for larger areas and involves acquiring a digital image of the object together with Spectralon® diffuse reflectance standards (Labsphere). At a second step the photograph is calibrated with the help of the standards in the image. After this, colour values from each pixel can be read.

All techniques were compared by using CIELAB colour notation for a 10° observer who is seeing the object under D65 light (6500 K daylight). Cyan, yellow and magenta surfaces of the same colour chart were measured with each technique. In the CIELAB colour space the difference in colour is given as ΔE. The reproducibility of the techniques was evaluated by comparing a first measurement (average of 10 single readings) with a second measurement made one or two months after the first. The two techniques with the integrating sphere gave good results with an average ΔE of 0.5 (Konica Minolta) and 1.2 (Dr. Lange). The measurement under microscope coupled with the VIS spectrometer gave an ΔE of 2.3 and the digital image processing of 15.0. For the evaluation of the accuracy, the values delivered by each technique were compared to the average values of all techniques, as the 'true' values of the colour chart are not known. The microscope/VIS spectrometer and the two techniques with the integrating sphere were with an ΔE of 8 to 9 all at the same distance from the mean value whereas the results of digital imaging were a bit of an outliner with an average ΔE of 22.

The most convenient method to get an overall idea of the colour and surface of the object is photographic documentation. However, the accuracy and reproducibility of the tested digital imaging technique for colour measurement seems to be inferior compared with other techniques. Therefore, the degree of accuracy required or desired in colour measurement should be specified before the digitalisation of works of art is taking place and it may be worth to implement a quality management tool to ascertain the veracity of the colour values into the process for high quality digitalisations.

Biographical statement (150 words)

Dr Stefan Röhrs finalized his PhD in chemistry at the Technical University in Berlin in 2003 with thesis titled: Authenticity investigation on Limoges painted enamels by means of micro x-ray fluorescence analysis. This work was related to the development of the portable µ-XRF Spectrometer (Bruker Artax).

He was two years (2005-2007) Post-Doctoral scientist at the Centre de recherché et de restauration des Musées de France (C2RMF) CNRS – UMR 171 in Paris as local contact for European scientist using the ion beam accelerator “AGLAE” at the C2RMF via the European EU-ARTECH project.

It followed two years (2007-2009) as scientist for material analysis of glass and other vitreous materials for archaeometic and conservation studies at the Department of Conservation and Scientific Research at The British Museum, London.

Since 2009 he is scientist at the Rathgen Research laboratory of the National Museums Berlin.