A Method to Determine the Minimum Number of Colour or Texture Measurements in Gonio-apparent Panels

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ABSTRACT

For gonio-aparent panels it is important to measure both colour and texture at different measurement geometries. Nowadays, there is only an instrument, the BYK-mac multiangle spectrophotometer, which is able to simultaneously measure six colour measurement geometries and three ones for sparkle. On the other hand, there are studies that recommend a minimum number of measurements to characterize solid colour samples with texture. However, no previous studies give recommendations to the minimum number of measurements needed to characterize the colours with special-effect pigments.

Our hypothesis is that colour panels incorporating special-effect pigments in their colour recipes will require a minimum number of measurements higher than in solid pigments panels. The objective of this work is to check our hypothesis using a BYK-mac. Therefore, we made a study of the minimum number of necessary measurements, both colour and texture, to optically characterize three types of samples (solid, metallic and interference). The parameters studied were the colourimetric values L*a*b*, which characterize the colour sample, and sparkle values SG that characterize the directional texture of the samples.

For the study, thirty samples were chosen for each type of colour recipe (a set of ninety samples). The colours were selected to cover all possible colour space. Twenty measurements were made for each sample, from which it was calculated and represented the cumulative mean value for L*, a*, b* and SG. Finally, we determined the minimum number of measurements when the cumulative mean value become constant.

The results show that the minimum number of measurements depends on both colour and texture of the sample as well as the measurement geometry.In addition, it also seems that the number of measurements depends on the lightness of the sample. However, this new hypothesis will be discussed more thoroughly in a future work.

1. INTRODUCTION

For gonio-apparent panels is important to measure both colour and texture at different measurement geometries. Nowadays, there is only an instrument, the BYK-mac multi-angle spectrophotometer, what is able to simultaneously measure six colour measurement geometries and three ones for sparkle. This device characterises colour by measuring to -15°, 15°, 25°, 45°, 75° and 110° from the specular angle. Following CIE standards these geometries are written as: 45°x:-60°, 45°x:-30°, 45°x:-20°, 45°x:0°, 45°x:30° and 45°x:65°, respectively. In the same way, it characterises sparkle by measuring in the perpendicular direction to the sample and with an illumination direction of 15°, 45° and 75°. Following CIE standards these geometries are written as: 15°x:0°, 45°x:0° and 75°x:0°, respectively.

On the other hand, there are studies that recommend a minimum number of measurements to characterise solid colour samples with texture (Prieto, et. al. 2010). However, no previous studies give recommendations to the minimum number of measurements needed to characterise the colours with special-effect pigments.

Our hypothesis is that colour panels incorporating in their colour recipe special-effect pigments (Pfaff 2008, Klein 2010) will require a minimum number of measurements higher than in solid pigments panels. The objective of this work is to check with the BYK-mac our hypothesis. To do this, we made a study of the minimum number of necessary measurements, both colour and texture, to optically characterise three types of samples (solid, metallic and interference). The studied parameters were the colorimetric values L*a*b*, which characterise the colour, and sparkle values S_G, which characterise the texture of the samples.

2. METHOD

2.1 Sample Selection

For the study, thirty samples were chosen for each type of colour recipe. The colours were selected to cover all possible colour space, as shown in next figure:

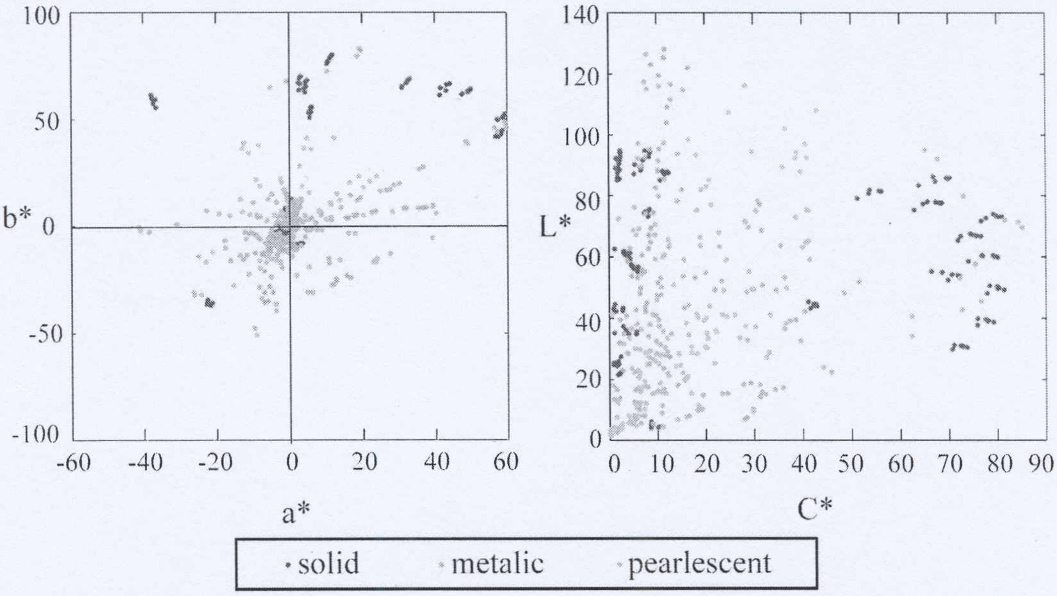

Figure 1: Sample selection represented in the chromaticity diagram.

Twenty measurements were made for each sample, from which was calculated and represented the cumulative mean value for L^* a^* b^* and S_G. We determined the minimum number of measurements with the following statistical formula (Triola, 2000) for stablising an objective method to determine the minimun number of measurements become constant:

$$n = \frac{N\sigma^2 Z^2}{(N-1)e^2 + \sigma^2 Z^2} \qquad (eq.1)$$

where *N* is the population size, s is the standard deviation of the population, *Z* is the value obtained by confidence levels (equivalent to 1.96 for a confidence interval of 95 %) and *e* is the acceptable limit of sampling error that assume was 1 units.

Finally we obtained a table for each type of pigment with the minimum number of colour measurements for individual sample and each measurement geometry and other table with the minimum number of sparkle measurements for individual sample and each measurement geometry.

2.2 Statistical analysis

Because the number minimum of measurements did not follow a normal distribution (in fact, for some geometries we had a constant set values), we cannot use parametric statistical studies. In this case, we think the box-plot is an efficient way to get an overview of quantitative data. The bottom and top of the box are always the first and third quartiles, and the band inside the box is always the second quartile (the median). The ends of the whiskers represent the minimum and maximum of all of the data. Any data not included between the whiskers should be plotted as an outlier with a dot, small circle, or star.

3. RESULTS AND DISCUSSION

In the next figures we show the box-plot of the minimum number of colour and sparkle measurements for the set of thirty samples with solid pigments, for the set of thirty samples with metalic pigments and for the set of thirty samples with pearlescent pigments.

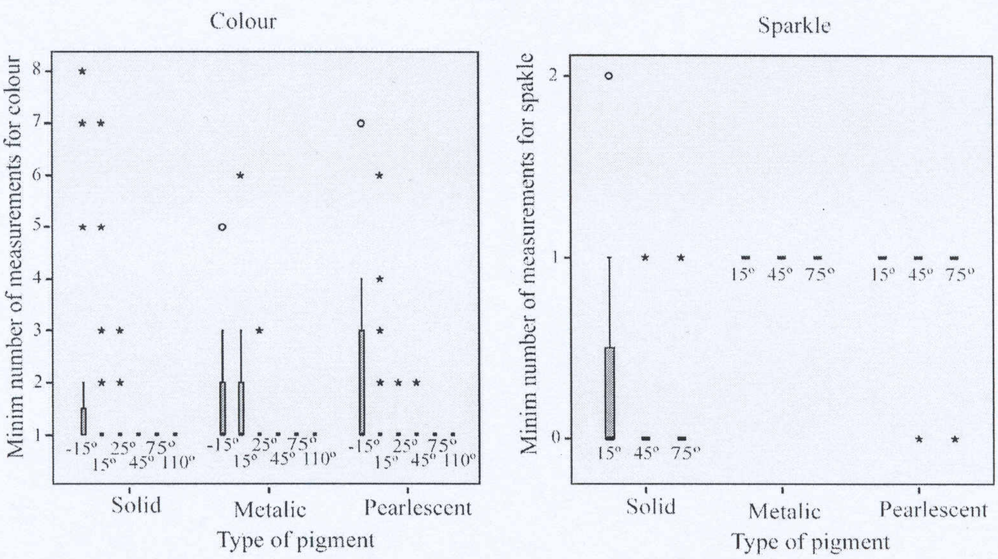

Figure 2: Box-plot of minimum number of colour (left) and sparkle (right) measurements in samples with different type of pigments for different geometry measurements.

When we can try to characterise colour, the results show that an unique measurement is necesary to determine the colour for four geometries further to specular angle (25°, 45°, 75° and 110° from specular angle), independently of type of pigment.

On the other hand, for two geometries closer to specular angle, a larger number of measurements is necessary to determine the colour for all type of samples. Although, a greater number of measurements is necesary to determine the colour for metallic samples (three measurements) that for solid samples (two measurements) and ever greater number of measurements is necessary to determine the colour for pearlescent samples (four measurements).

When we can try to characterise sparkle, the results show an unique measurement is necesary to determine the sparkle independently of type of pigment or measurement geometry.

More specifically, the results show that for solid samples none measurement is necesary, which is consistent with the fact that solid samples should not have sparkle. For solid and pearlescent samples one measurement is necessary.

In addition, although the partial dependence of the minimum number of measurements with L*a*b* are not shown in this work, it also seemed that the number of measurements will depend on the lightness of the sample. However, this new hypothesis will be discussed more thoroughly in a future work.

4. CONCLUSIONS

In particular, we can conclude that for characterization colour, the results show an unique measurement is necessary to determine the colour for four angles further to specular angle (25°, 45°, 75° and 110° from specular angle), independently of type of pigment. For two geometries closer to specular angle (-15° and 15°) two measurements are necessary for characterization colour of solid samples, three measurements for metallic samples and four measurements for pearlescent samples.

When we can try to characterise sparkle the results show that for solid samples none measurement is necesary, which is consistent with the fact that solid samples should not have sparkle. For solid and pearlescent samples only one measurement is necessary.

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