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The influence of total base ink coverage on the uniformity of digital prints overprinted with pearlescent inks

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Introduction

Print uniformity is an important parameter that can determine perceived quality of a printed product. If the product is of low print uniformity, its quality is often regarded as non-satisfactory. The uniformity depends on the printing process, paper and the ink used, as well as their interaction. It is often a problem in electrophotography, due to the nature of the printing process.

In this work we were interested in the uniformity of electrophotography prints overptinted with ink containing pearlescent pigments since we found no publications on the topic. These types of pigments are often used in packaging for achieving the effect of subtle, pearl shine as well as the colour travel effect (change of a colour with the change of the angle of viewing/illuminating).

Problem Description

The goal of this work was to test how the electrophotography ink layer interacts with pearlescent inks and whether the uniformity of overprinted sample is influenced by the total base ink coverage.

Methods

For this study we used nine pearlescent pigments that differed in their composition and, therefore, their interference colour (Table 1).

Table 1

Pigments used in the study

Pigment	Interference colour	Number of components	Composition
504 Red	Red	2	Mica coated with: ferric oxide
300 Gold pearl	Pearl-gold	3	Mica coated with: titanium dioxide, ferric oxide
221 Rutile Fine Blue	Blue	3	Mica coated with: titanium dioxide, tin oxide
231 Rutile Fine Green	Green	3	Mica coated with: titanium dioxide, tin oxide
223 Rutile Fine Lilac	Lilac	3	Mica coated with: titanium dioxide, tin oxide
325 Solar gold satin	Gold	4	Mica coated with: titanium dioxide, ferric oxide, silicon dioxide
Blue-shade silver SW 9605	Blue-silver	4	Mica coated with: titanium dioxide, tin oxide, auxiliaries
T20-03 WNT Tropic sunrise	Green-orange*	5	Silicon dioxide coated with: titanium dioxide, tin oxide, zirconium oxide, auxiliaries
GP Rutile Blue Green WNT	Turquoise	7	Mica coated with: titanium dioxide, cobalt titanate, zirconium oxide, aluminium oxide, tin oxide, auxiliaries

The grey and black patches (K of 50% and 100%) size of 10x10 cm were printed matte art paper on Xerox DocuColor 252 digital printer. They were overprinted with the pearlescent pigments dispersed in the aqueous ink vehicle (pigment concentration of 15%). Overprinting was done in screen printing where two layers of pearlescent ink were deposited over the paper and previously printed patches. Prints were further digitized by Canon CanoScan 5600 F scanner in the resolution of 600 ppi.

To determine print uniformity we used two parameters from Grey-Level Co-occurrence Matrix (GLCM) – Homogeneity and Entropy. Calculation of the parameters was performed in Matlab R2016a in all directions (horizontal, vertical, -45° and 45°). The mean value of the parameter calculated in all four directions was taken into account for further analysis.

Results

Unprinted paper used in the experiment had the most uniform surface (Homogeneity was 1, while the Entropy was 0). Adding the pearlescent inks did not change the uniformity in case of ink with Blue, Green, Lilac and Green-Orange pigment, while in the rest of the cases the change was minimal.

Figure 1 shows the Homogeneity and Entropy values for prints where pearlescent inks were printed over grey colour.

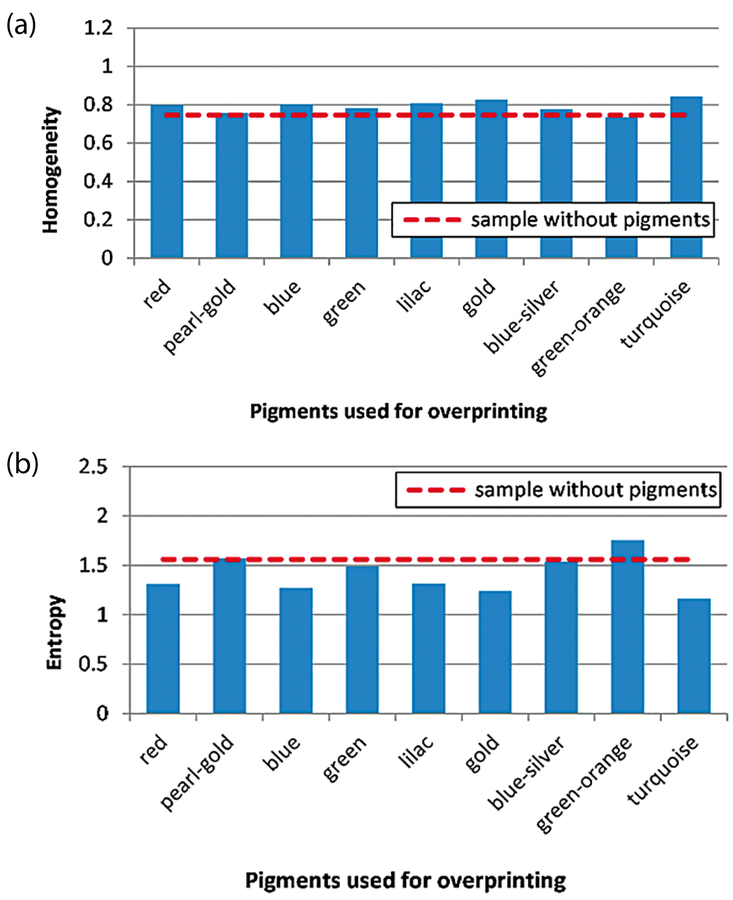

Figure 1

(a) Homogeneity and (b) Entropy of prints with grey base colour

When pearlescent inks were printed over the grey patch the uniformity was the same or even better for all the pigments. This means that overprinting the grey ink with pearlescent inks lowers the errors caused by the printing process.

Black patch had almost perfect uniformity with Homogeneity quite close to 1 and Entropy of just 0.24. Adding the pearlescent inks significantly reduced uniformity. By observing the scanned images of prints it was noticed that in all the cases parts of the prints were left uncovered by pigments (Figure 2, left). This was not the case when pigments were applied over the grey colour (see Figure 2, image on the right).

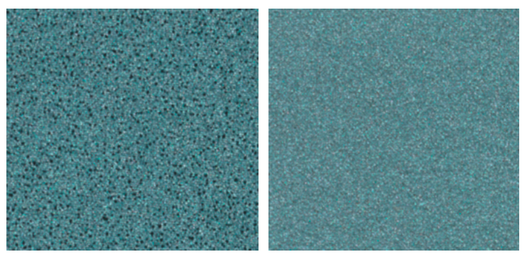

Figure 2

Part of the scanned image of black and grey patch overprinted with Blue-silver pigment

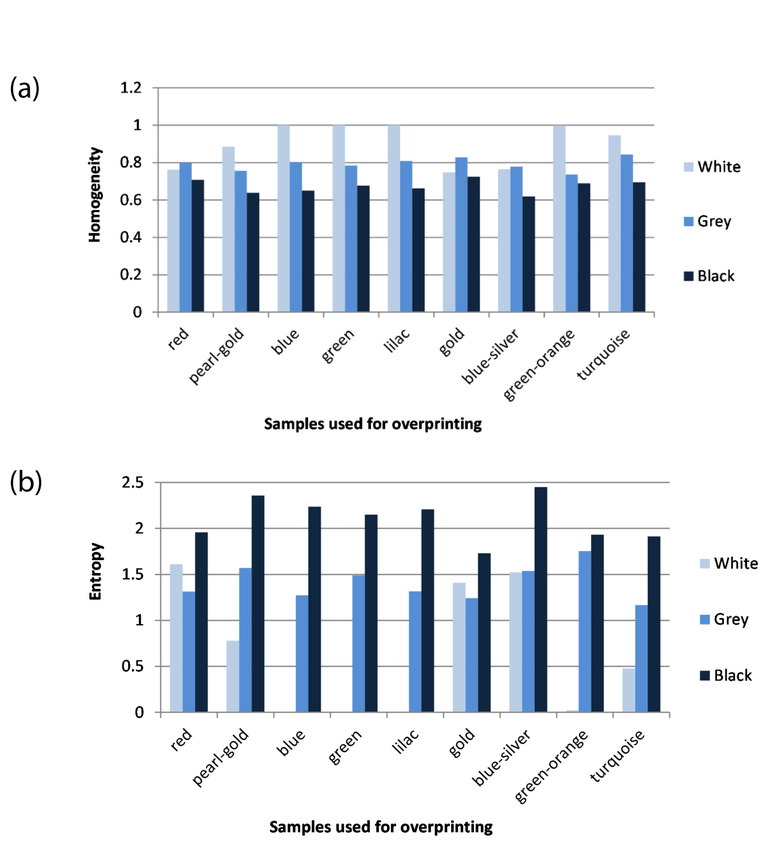

Figure 2

Comparative view of print (a) Homogeneity and (b) Entropy with respect to the base colour

From the comparative view it is evident that uniformity was the best when pigments were printed directly to the paper (in almost all the cases Homogeneity was the highest and Entropy lowest), then grey and finally black ink. Gold and Red pigment are the only two exceptions where samples with grey base colour has slightly better uniformity in comparison to white.

Conclusion

The best results in print uniformity of overprinted samples were obtained when pigments were printed directly to the paper, following the cases when they were printed over the grey and black prints. Therefore, it is concluded that the total base ink coverage significantly influences the uniformity of electrophotography prints overprinted with pearlescent inks. Such results can be explained by the lower capacity of electrophotography toner to attract aqueous ink vehicle in which pearlescent pigments were dispersed. Hence, if the pearlescent pigments are to be printed over the solid colour patch printed in electrophotography alternative options for ink carriers should be considered.

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