

การจำลองขอบเขตสีของระบบหมึกพิมพ์อิงก์เจ็ทบนวัสดุพิมพ์ชนิดเคลือบผิวและไม่เคลือบผิว



นิรมล เกษตรศิลป์ชัย

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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต  
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ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

SIMULATING THE COLOUR GAMUT OF INK-JET INK SYSTEMS ON COATED AND  
UNCOATED SUBSTRATES



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ปัจจุบันนี้มีการวิจัยและพัฒนาสารให้สีขึ้นมากมาย ซึ่งสามารถให้ขอบเขตสีที่กว้างขึ้น ปัจจัยสำคัญในการเลือกสารให้สีที่สามารถให้ขอบเขตสีที่กว้างที่สุดต้องคำนึงถึงต้นทุนที่ต่ำด้วย ในงานวิจัยนี้ศึกษาเกี่ยวกับการจำลองขอบเขตสีของหมึกพิมพ์อิงค์เจ็ทที่พิมพ์บนวัสดุพิมพ์ชนิดเคลือบผิวและไม่เคลือบผิวโดยใช้ทฤษฎีคูเบลคา-มังก์แบบสองตัวแปร ซึ่งกล่าวถึงสมบัติทางด้านทัศนศาสตร์ของหมึก ได้แก่ สัมประสิทธิ์การดูดกลืนแสง (K) และสัมประสิทธิ์การกระเจิงแสง (S) ค่า K และ S ที่คำนวณได้ไม่ขึ้นต่อกัน เมื่อใช้ทฤษฎีคูเบลคา-มังก์แบบสองตัวแปร ในการทดลองได้ใช้หมึกประเภทสีย้อม 14 ชนิด (ซึ่งได้รับการสนับสนุนจาก บริษัทแคนนอน) ทำการปรับเทียบหมึกเพื่อคำนวณสมบัติด้านทัศนศาสตร์ของหมึกแต่ละชนิดที่พิมพ์บนกระดาษเคลือบผิวและไม่เคลือบผิว จากนั้นสร้างสเปรดชีต (spreadsheets) และ เขียนโปรแกรมด้วยภาษาวิซวลเบสิก (Visual Basic codes) เพื่อให้ง่ายต่อการคำนวณสัมประสิทธิ์การดูดกลืนแสงและสัมประสิทธิ์การกระเจิงแสง และการจำลองขอบเขตสี มีการปรับความสัมพันธ์แบบนอนลิเนียร์ระหว่างสัมประสิทธิ์การดูดกลืนแสงและความเข้มข้นของหมึกอิงค์เจ็ท (C) ให้มีความสัมพันธ์เชิงเส้นด้วยสมการ  $K = aC + bC^2 + cC^3$  ตลอดทุกความยาวคลื่น สัมประสิทธิ์ค่าความถูกต้อง (correction coefficients) ของกระดาษเคลือบผิวและของหมึกพิมพ์ต่างกันโดยที่  $r_c$  และ  $r_i$  ของวัสดุพิมพ์เป็น 0.021 และ 0.600 ตามลำดับ  $r_c$  และ  $r_i$  ของหมึกพิมพ์เป็น 0.007 และ 0.600 ตามลำดับ จากผลนี้ให้ค่าความแตกต่างของสีเฉลี่ยระหว่างค่าการสะท้อนแสงที่ทำนายได้และค่าการสะท้อนแสงที่วัดได้ของหมึก 14 ชนิด เป็น 4 การจำลองขอบเขตสีให้ผลดี ชุดหมึก 4 สี ซึ่งให้ขอบเขตสีที่กว้างที่สุดประกอบด้วยสีย้อมสีน้ำเงิน (Direct Blue 199) สีม่วงแดง (Acid Magenta 1) สีเหลือง (Direct Yellow 86) และสีดำ (Direct Black (reddish)) ขอบเขตสีของหมึกชุดนี้ครอบคลุมขอบเขตสีของภาพดิจิทัล "วูล" (Wool digital image) แต่ไม่สามารถครอบคลุมถึงค่าความสว่างของภาพ "วูล" ที่อยู่ในช่วง 11.7 ถึง 100.0 ค่าความสว่างต่ำสุดถึงสูงสุดที่หมึกชุดนี้ผลิตได้มีค่าประมาณ 22.8 ถึง 92.5

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สาขาวิชา เทคโนโลยีทางภาพ  
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ลายมือชื่อนิรมล เกษตรศิลป์ชัย .....  
ลายมือชื่ออาจารย์ที่ปรึกษา..... พิชญดา เกตุเมฆ .....  
ลายมือชื่ออาจารย์ที่ปรึกษาร่วม..... Hiroonichi. Noguchi

## 4472304123: MAJOR IMAGING TECHNOLOGY

KEY WORDS: COLOUR GAMUT / DYE-BASED INK / INKJET INK / KUBELKA-MUNK THEORY

NIRAMOL KASADESINCHAI : SIMULATING THE COLOUR GAMUT OF INK-JET INK SYSTEMS ON COATED AND UNCOATED SUBSTRATES.  
THESIS ADVISOR : PICHAYADA KATEMAKE, Ph.D. THESIS CO-ADVISOR : HIROMICHI NOGUCHI, Ph.D. 120 pp. ISBN 974-17-2376-8

Nowadays, research and development in colourants have led to a number of new colourants with a wider colour gamut. It is important to select the widest gamut of colourants at the lowest cost. This study intended to simulate the colour gamut of inkjet inks printed on coated and uncoated substrates using the two-constant Kubelka-Munk theory to obtain the optical properties of the inks: absorption coefficients (K) and the scattering coefficients (S). The K and S values were determined independently. Fourteen dye-based inks, supplied by Canon, were employed for calibration of prints to determine their optical properties on coated and uncoated substrates. Spreadsheets and the Visual Basic codes were developed to make the calculations much easier. The nonlinear relationship between absorption coefficients and concentration of inkjet ink (C) was characterised by a power series of the equation  $K = aC + bC^2 + cC^3$  for all wavelengths. The correction coefficients for coated paper (PR-101) found as  $r_{e,sub}$ ,  $r_{i,sub}$ ,  $r_{e,print}$  and  $r_{i,print}$  were 0.021, 0.600, 0.007 and 0.600 respectively. This resulted in the average colour difference,  $\Delta E_{ab}^*$ , between the predicted reflectance and the measured reflectance of 4 when the single colour of fourteen dyes was investigated. The application of gamut simulation gave a good performance. The four colour inkset giving the largest gamut was the inks that contained Direct Blue 199, Acid Magenta 1, Direct Yellow 86, and Direct Black (reddish). This inkset covered hue of the wool digital image (SHIPP) but it could not cover the lightness of wool picture of 11.7-100.0. The lowest and the highest lightness that this inkset can produce are about 22.8 and 92.5.

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Niramol Kasadesinchai

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