Research on Art Design System of Industrial Dyestuff Colour Matching with Computer Aid

Ying Yu, Dantong Yu

Shenyang Jianzhu University, Shenyang 110168, China

Abstract. The success rate of computer colour matching not only depends on the colour matching theory and algorithm, but also limited by the basic data of colour matching. In addition to the traditional accuracy analysis method, colour gamut analysis is added. We take the establishment of basic data for dyeing polyester fabrics with disperse dyes as an example to discuss the rationality of basic data for computer colour matching. The model can obtain colour matching results with a colour difference of less than 1 after 1-2 colour corrections, and can meet the basic requirements of multi-component, fixed-proportion colour matching and colour correction in the production of colour spinning.

Key words: Computer, Industrial dyes, Colour matching design system, Colour matching technology.

1. Introduction

With the advancement of computer colour measurement and colour matching system (CCM) technology and the further reduction of hardware and software prices, its application in chemical, paint, plastic, ink, printing and dyeing industries has become more and more popular. The colour measurement and colour matching system plays an important role in the colour management of printing and dyeing products, sample preparation and workshop production. It effectively shortens the product delivery time, improves the accuracy of the colour once, reduces the production cost, and brings huge economic benefits to the enterprise.

Computer colour matching is based on the spectral reflectance or chromaticity parameters of standard colour samples. Based on a certain colour matching theory and model, according to a certain algorithm, the colour matching basic data stored in the system is used to obtain the dyeing standard sample after complex calculations [1]. The required colorant formula. The computer colour measurement and matching system includes programs such as colour measurement, storage of basic data, prediction formula and colour correction. Therefore, the computer colour matching system cannot only predict the colorant formula, but also easily predict the metamerism, scientifically manage the formula, and quickly modify the colour and make full use of the printing and dyeing residual liquid. However, in the final analysis, the accuracy of colour matching and colour correction is the key to the success or failure of computer colour matching systems. In this paper, by improving the method of determining the unknown parameter M value in the Stearns-Noeche algorithm and the calculation method of the initial formula, it seeks a computer colour matching algorithm that is more suitable for production practice and has higher colour matching efficiency.

2. Stearns-Noechel model

The mixing of fibres is only physical mixing. In theory, there should be a certain additive relationship. Assuming that there is an intermediate function $f\left[R(\lambda)\right]$, there is

$$f\left[R(\lambda)\right]=\Sigma x_i f\left[r_i(\lambda)\right] \tag{1}$$

In the formula: $R(\lambda)$ represents the reflectance value of the mixed colour sample at the wavelength. $r_i(\lambda)$ represents the reflectance value of the i component monochromatic fibre under the wavelength λ. x_i represents the proportion of the i component monochromatic fibre in the total mass of the mixed colour fibre [2]. The proportion of coloured fibres should satisfy $\Sigma_i x_i=1$.

In 1944, Stearns and Noechel obtained an empirical formula called Stearns-Noeche model through experiments. The formula is as follows:

$$f[r(\lambda)]=\frac{1-r(\lambda)}{M[r(\lambda)-0.01]+0.01} \tag{2}$$

Where: M is a variable constant. $f[r(\lambda)]$ is the intermediate function of reflectance $r(\lambda)$ with respect to wavelength λ. From equation (2), the relationship between the reflectivity $r(\lambda)$ and the intermediate function $f[r(\lambda)]$ can be deduced as

$$r(\lambda)=\frac{0.01\times(M-1)\times f[R(\lambda)]+1}{M\times f[R(\lambda)]+1} \tag{3}$$

When the value of the parameter M is known and the reflectivity $r(\lambda)$ of the monochromatic fibre, the intermediate function $f[r(\lambda)]$ of the monochromatic fibre can be calculated using equation (2). When the colour mixing ratio x of the monochromatic fibre is known, the intermediate function $f[r(\lambda)]$ of the colour mixing fibre can be calculated using formula (1). At this time, formula (3) can be used to obtain the fitting reflectance $Rbat(\lambda)$ of the mixed colour fibre, and then the colour difference formula can be used to solve the fitting colour difference between the fitted reflectance $Rbat(\lambda)$ of the mixed colour sample and the standard reflectance $Rsat(\lambda)$ and other chromaticity's. parameter. Based on this algorithm, this paper writes a set of colour matching software for coloured spinning in MATLAB software, which includes two main modules: colour matching and colour repairing.

3. Colour matching system design

3.1 Hardware design

Computer colour measurement and colour matching system is mainly composed of 3 parts: spectrophotometer; colour measurement and colour matching software; computer and printer. The spectrophotometer is the most important part of the hardware [3]. After all colours are measured by it, they are converted into data and transmitted to the software for processing. The spectrophotometer is usually composed of a light source, a monochromator, an integrating sphere, a photodetector, and a data processing device. Most of them use d/0 or d/8 illumination receiving mode, continuous scanning in the visible light range, with an interval of 10nm or 20nm sampling. The measuring hole of the colorimeter has large (LAV), medium (MAV), small (SAV) and other areas for selection. The two working modes of specular reflection include/exclude (SCI/SCE) can be manually switched or set by software to enable/disable.

3.2 Software function

Software is the core of the entire colour measurement and colour matching system, and the price of many software exceeds the price of hardware. There are many colours measurement and colour matching software's, such as MATCH-TEXTILETM from Data colour, Textile-Master from X-Rite, EZ Match from Hunter lab, and EXPERT COLOR SYSTEM from Daclim Starlet. Most colour measurement and colour matching system software includes the following functional modules.

1) Colour measurement, colour quality control (QC), including colour measurement, colour difference analysis and calculation, analogy gray card rating, product pass/fail judgment, etc. 2) Colour matching includes two parts: laboratory colour matching and workshop colour matching. Each part is divided into single fibre fabric and blended fabric colour matching. 3) Data management, including dyeing materials, dye characteristics, dyeing methods, combinations of three primary colours, customer information, project information, basic data, learning data management, etc. 4) Practical tools, including measurement aperture selection, black (light trap) white (ceramic plate)

calibration, illuminator/observer selection, operating environment setting, spectrophotometer calibration, data backup, etc.

3.3 Basic database construction

The establishment of the basic database is a prerequisite for computer colour matching, which is related to the success of computer colour matching and the accuracy of formula prediction. The establishment of the basic database is mainly completed through the Dyeset Preparation module. Each dyeing group in the database includes basic colour sample data under different concentration gradients of different dyes, as shown in Figure 1.

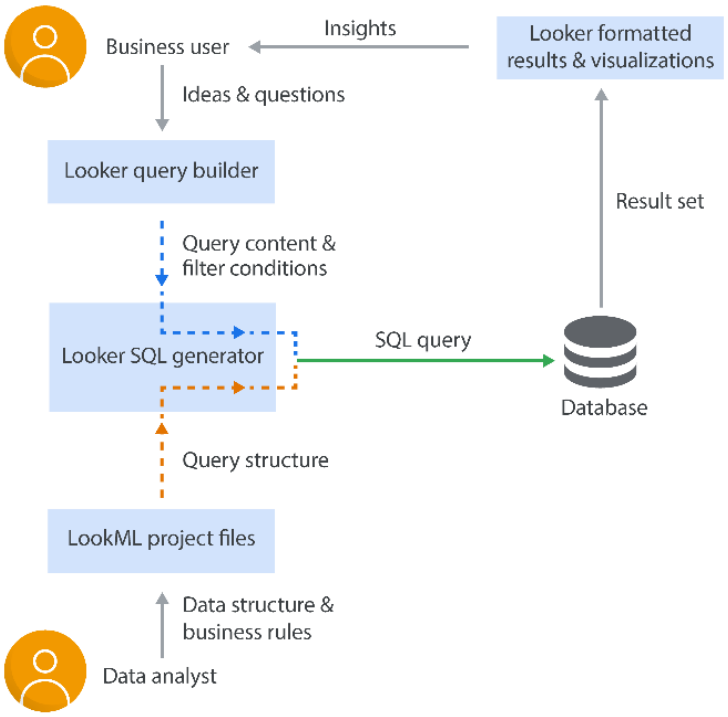


Figure 1. The composition of the basic database

3.4 Dye dosage adjustment

In practical applications, automatic colour matching is performed according to the colour of the standard sample, and the sample is dyed according to the predicted formula. When the colour difference between the sample and the standard sample is too large to meet the requirements, a correction calculation is required. In the correction calculation, several correction schemes are given according to different correction methods [4]. When the colour difference between the standard sample and the sample is large, the correction effect is more obvious. When the sample is close to the standard sample, sometimes due to many interference factors, it is easy to fluctuate, and it is difficult to approach the target colour after repeated corrections. Therefore, when the colour difference is not large, the experienced operator can adjust the formula by observing the K/S curve or the DA-DB diagram and adding the user experience.

3.5 Calculation process of colour matching module

Based on the calculation method of the above M value and the solution method of the initial formula of the monochromatic fibre, the calculation process of the improved colour matching module is shown in Figure 2.

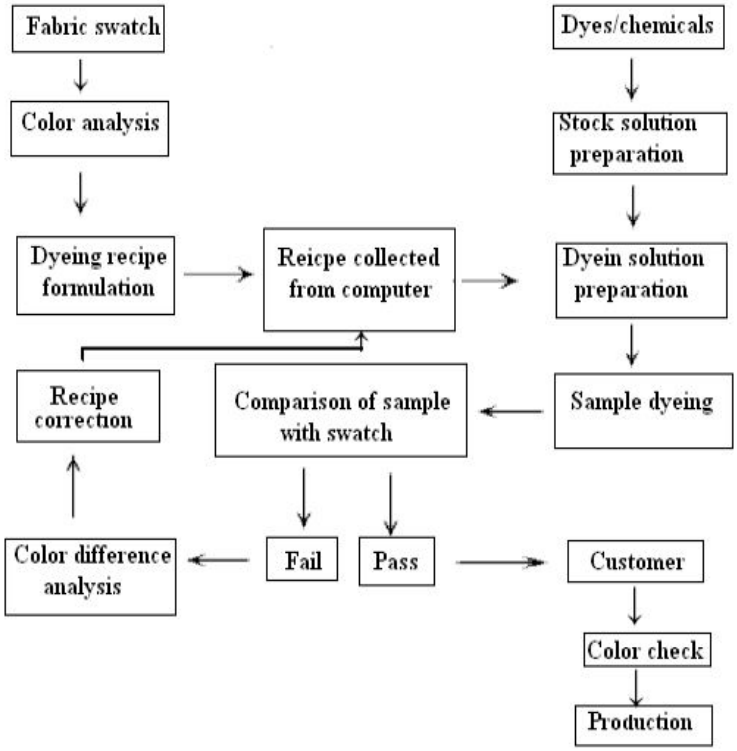


Figure 2. Colour matching module calculation process

When using this colour matching module to match the colour of the standard sample, the reflectance of the standard sample must be tested first for subsequent colour matching; secondly, it is necessary to carefully observe which colours are in the standard sample, and then select the single-color fibre based on experience and test the single-color fibre的Reflectivity. Then according to subsection 1, the fitting reflectance can be calculated. Calculate the fitted colour difference between the standard sample reflectance and the fitted reflectance through the colour difference formula [5]. If the colour difference meets the requirements, the colour mixing quality ratio of the monochromatic fibre at this time and the corresponding M value can be output; if the colour difference does not meet the requirements, then re-assign the value of M and the colour mixing quality ratio of monochromatic fibre until the colour difference meets the requirements.

3.6 Colour correction module

No matter how close the fitting formula given by the colour matching module is to the true formula of the mixed colour sample, there will always be operating errors and machine errors during the proofing process, and errors will also occur due to changes in the environment and other factors. Therefore, the spun samples will always match the standard There is a colour difference in the sample. When the colour difference is too large to meet the production requirements, it is necessary to modify the colour of the sample. The colour correction methods used by previous scholars include reflectance colour correction and tristimulus colour correction. But when using this algorithm for colour correction, the colour correction result is not ideal, and this colour correction algorithm cannot meet the colour correction requirements of "multi-component, fixed ratio" mixed colour samples, so this article also improves the colour correction module. The improvement idea of the colour correction module still starts from the programming idea of the assignment cycle, and the calculation process of the improved colour correction module is shown in Figure 3.

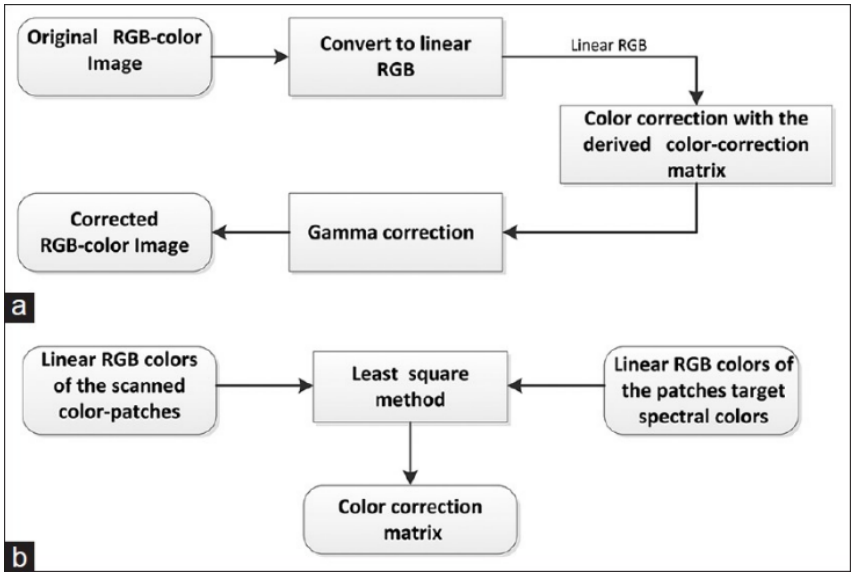


Figure 3. The calculation process of the colour correction module

4. System Test

Basic colour sample reverse matching experiment

The basic colour sample reverse matching is to store the relevant data of the basic colour sample as the basic data, and at the same time use the basic colour sample as the standard sample for colour matching, and compare the density calculated by the colour matching system with the actual density to find the relative error. This error is not only related to the accuracy of the basic colour sample data, but also related to the colour matching algorithm [6]. If the colour matching program adopts the curve fitting method, the size of the anti-match error depends on the effect of the curve fitting, and the anti-match error of the point farther from the fitted curve is larger. According to the result of the reverse matching, the points with larger errors can be eliminated or the concentration can be reset. It can also be used to check whether the basic data is suitable for the colour matching program. Table 1 is the result of using two computer colour matching systems of X-Rite "Colour" i7 and Watercolour" SF600 to reverse the basic colour samples. Although the two-colour matching software reversed the colour material density, they can meet the requirements, indicating the basic data the accuracy is high. The reverse matching result when the lowest concentration is 0.1 shows that the colour matching system is relatively difficult to control the first 14 low concentration point.

Table 1. Anti-matching results of the dark red colour

Actual concentration	X-Rite Colour i7		Data colour SF600	
	Calculate the concentration	Relative error/%	Calculate the concentration	Relative error/%
0.1	0.109	9.1	-	-
0.15	0.15	0.07	0.15	0.07
0.25	0.25	0.08	0.25	0
0.45	0.451	0.18	0.45	-0.09
0.7	0.701	0.17	0.7	0.04
0.95	0.95	0	0.951	0.06
1.2	1.199	-0.09	1.201	0.11
1.5	1.499	-0.09	1.501	0.08
2	1.999	-0.07	2.003	0.12
3	2.992	-0.25	3	0

Observe the relationship between dye intensity/relative colour intensity and C

The relationship between the dye's Strength and C generally changes regularly with the increase of the concentration. If there is a big up and down jump, it indicates that the basic colour sample produced has a problem. It can be seen from Figure 2 that the values of Strength SUM and Strength W SUM are very close, and Strength as a whole decrease regularly as the concentration increases. The third point from the right in Figure 4(a) shows a slightly higher trend on the curve. In other methods, such as lg(K/S)-lgC and Collor value-C, the abnormalities of this point are all Not as obvious as Figure 4(a). Although this abnormal point is only slightly higher and has little effect on the trend of the curve, it can show that the sensitivity of this method is higher.

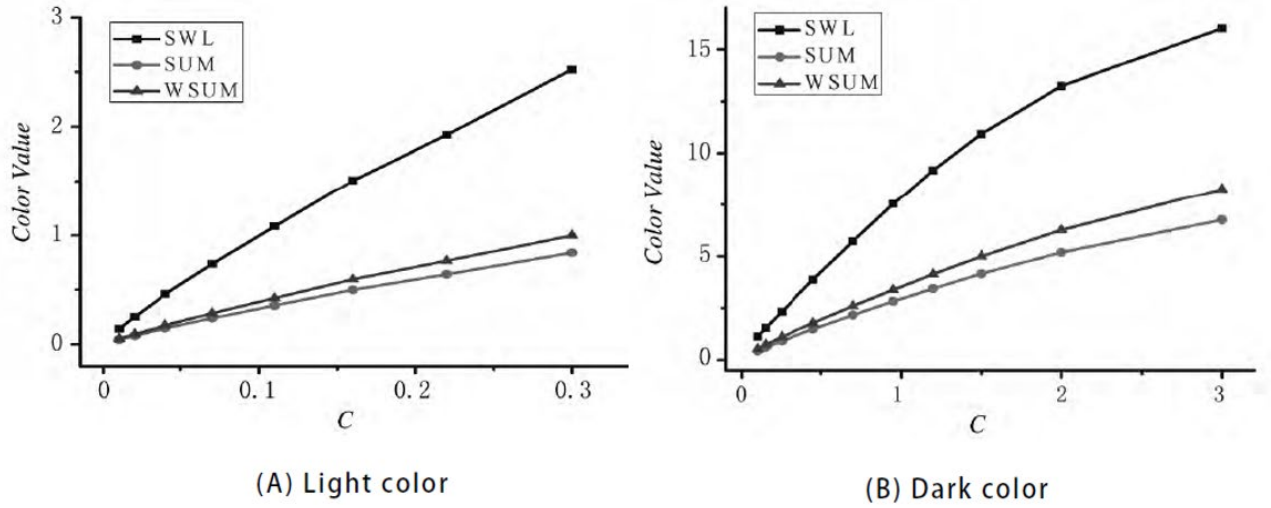


Figure 4. The relationship between the two-colour red samples of Colour Value and C

5. Conclusion

The scientific rationality of the basic colour matching database is an important basis for ensuring the success of computer colour matching and improving the success rate of a colour matching. Therefore, it is necessary to check the rationality of the basic colour matching data. This paper takes the dyeing of polyester fabrics with disperse dyes as an example for experimental research. The results show that adding colour gamut analysis to the usual accuracy analysis can conduct a more scientific and comprehensive test on the rationality of the basic data of colour matching to provide accurate and comprehensive the basic database of spectral wide colour gamut.

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