

Bringing Traditional Thai Colours to Life using an Original Developed Software System

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ABSTRACT

In 2008, the Department of Imaging and Printing Technology initiated a project, within the Faculty of Science in Chulalongkorn University, called Traditional Thai Colour Naming Project. Toward the end of 2010 we imagined a method for identifying and analyzing the traditional Thai colours based on Siripant's work. In January 2011 we assumed full responsibility for this project with only two years left to finalize a four year project. While describing the methodology in a first article, we already realized that it is impossible to finish the project using that method. The problems are outlined in the first article we wrote. In the second stage of our research we improved the methodology and created a software to be used as a tool. We mentioned it in a second article but, due to different review speed and editing time, the second article was published first. The present paper is a short description of the software system itself, of its usage in traditional colour identification and of the context of its creation. This paper is written after submitting the complete study on traditional Thai colours and the Traditional Thai Colour Name Dictionary to Color Research and Application.

1. INTRODUCTION

Traditional Thai Colour Naming Project was part of the first five-year academic development plan of Chulalongkorn University (2008-2012). The allocated budget for this plan is known as Chulalongkorn Centenary Fund. The project was initiated in 2008 and started in 2009. Everyone in the department of Imaging and Printing Technology was invited to participate. Activities in the first two years have been of preparative nature, such as: ordering Munsell sheets from abroad, recovering some of the work done by Siripant (Siripant, 1988) until 1988 (mostly destroyed by floods), investigating Thai colour names in four regions of Thailand.

After assuming full responsibility of this project in 2011, we wrote an article about the applied methodology for identifying and analyzing traditional Thai colours, outlining the problems that we were facing, mainly the high colour inhomogeneity on samples painted by artists (Katemake and Preda 2013). Our first method could handle only a limited degree of inhomogeneity, as described in that article. The article mentions some possible solutions that we were prepared to test. Shortly after submitting the first article, we thought about the possibility of using a scanner glass as wide measurement port to obtain good average CIELAB values, in D65/2o viewing conditions, for the inhomogeneous samples. Knowing about research related to obtaining colorimetric data from scanners, we believed to be quite easy finding software products that turn scanners into colorimeters. We tried hard to find one but could not. Therefore, we decided to create our own system. The software is mentioned in a second article (Preda et al. 2011) that was published faster than the first one we wrote (Katemake and Preda 2013). The published results of our intensive work might create some confusion if not followed in their strict chronological order.

2. ORIGINAL SOFTWARE USED IN COLOUR INVESTIGATION

The software was developed as a tool in research, not as a research object. It was initially created to provide solutions in our Traditional Thai Colour Naming Projects, not as an aim.

2.1 Short self answered questionnaire about the software system

1. What is the name of the software and how was the name chosen? We named the software Trichromatic Colour Analyser, abbreviated TCA. The name was chosen to reflect its basic function: Trichromatic Colour Analysis.

2. What is the purpose of this software and what is its main advantage? TCA turns a scanner into a colorimeter in order to use the scanner glass as measurement port. It measures colour samples on flexible sized areas, unlike dedicated colorimeters that are limited by their fixed aperture of the measurement port. The main advantage of this software system resides in the long list of colorimetric calculations that exploit its unique feature of measuring flexible sized areas between 0.07 to 100 sqmm.

3. Why do you call TCA sometimes “software” and other times “software system”? TCA was initially a software application that was destined to offer a reasonable solution to the inhomogeneity problems of artists’ paintings in our Traditional Thai Colour Naming Project. Encouraged by the fact that no scientific software was released in Chulalongkorn University until 2011, according to the Universities’ IP office, we decided to create a fully functional software system that controls the scanner, overrides its factory settings, performs a large variety of colorimetric calculations etc., through easy-to-use drop-down menus and graphical interfaces. However, we still refer to it many times just as “software”.

4. Using a scanner for colorimetrically-accurate colour capture is the object of colour management and has been achieved somewhat through the use of ICC profile. Is TCA another colour-management software? Absolutely not. The main objective of a colour management software is to obtain good matches across colour devices connected to computer, colorimetric accuracy being sacrificed in favour of offering pleasing images on these devices rather than colour-accurate ones. TCA’s primary goal is to obtain colour accurate information from scanner. It defines a colourspace (TCA colourspace), based on user’s needs and system’s limits, in which any colour samples can be analyzed with the accuracy of a colorimeter. This approach is fundamentally different compared with colour management software. Therefore, TCA cannot be assimilated to this type of software.

2.2 Using TCA in traditional colour identification and analysis

We exemplify the use of TCA for identifying ‘Khiao Tong On’ colour name from samples painted by 6 artists (Fig 1). The scanner used is an Epson GT-20000. All CIELAB values are calculated in D65/2° viewing condition.

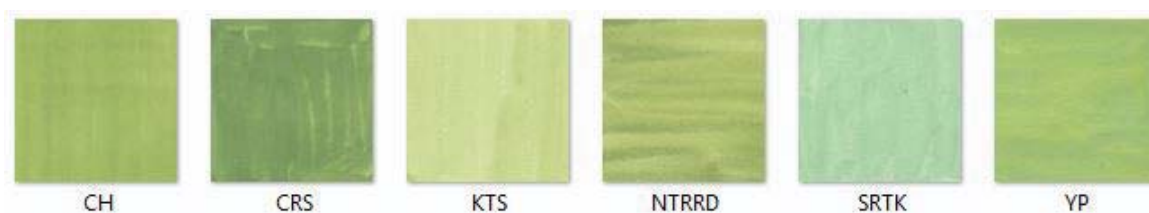


Figure 1: Khiao Tong On color name painted by 6 artists.

Each sample shown in Fig.1 is marked with the abbreviated name of the artist who painted it. Samples are scanned and introduced in TCA's colour catalog for creating the database, which can be of 2 kinds: with equally sized samples or random sized scanned samples. Size cannot exceed 100 x 100 mm. There are 2 ways of scanning: one with TCA's Location Calibrator and a software module developed for it, another one through a different software module that controls the scanner's TWAIN interface. The Location Calibrator places the sample at a determined distance from the scanner-glass-edges and forces user to scan always in the same position, keeping consistency of measurements and eliminating part of the influence that image noise could have on TCA's colour correction algorithms. Samples are placed on scanner glass with a pair of gloves to avoid the interference of fingerprints. TCA can be operated through voice commands and has built in voice user guides, so that gloves do not have to be removed when handling multiple scans at once, as in our case. Next step is to load each file in TCA's Colour Engine. This software module performs processes such as colour corrections and CIELAB calculations for each colour position (0.07 sq. mm) on the physical sample, identification of the most frequent colour and of the average colour on the sample, and generates files with processed data for each scanned file. Colour Engine is a preparative module that does the most time consuming and repetitive calculations needed in all future colorimetric-related computations that TCA performs for analyzing and for matching the scanned sample trichromatically. After using the Colour Engine, files can be analyzed with various tools, some of them developed at suggestion of participants in presentation workshops since February 2012. For the exemplified case we use only tools for calculating colour differences among most frequent colour and average colour on each sample, for calculating colour differences across the 6 samples and for performing colour matching with the digitized Munsell and NCS dictionaries. Due to space limitations, we just show results with a few comments.

3. RESULTS AND DISCUSSION

Table 1 contains the calculated average CIELAB values for each sample in the columns marked with "X" and the most frequent colour's CIELAB values identified on each sample, in the column marked "MF". The last row of Table 1 shows the colour difference between average and most frequent colour for each sample, expressed in ΔE_{00} units.

Table 1. Average and most frequent colours on artists' samples (TCA CIELAB D65/2°).

	CH		NTRRD		CRS		KTS		SRTK		YP	
	X	MF	X	MF	X	MF	X	MF	X	MF	X	MF
L*	73.41	72.83	75.09	75.61	64.29	63.60	85.44	85.74	83.04	83.13	76.26	74.65
a*	-20.35	-20.29	-16.70	-16.58	-20.06	-20.02	-14.34	-14.19	-19.39	-19.50	-21.83	-21.61
b*	38.21	38.12	35.33	35.75	27.69	27.42	31.48	31.08	16.85	16.95	35.35	32.27
ΔE_{00}	0.44		0.44		0.59		0.26		0.09		1.75	

The high inhomogeneity of some samples can be seen with naked eye in Fig 1. Using TCA's module for determining colour distributions on the samples we obtain results of over 90% individual colours within a tolerance of $\Delta E_{ab} = 4$ towards the calculated average colour only for CH (97.72%), KTS (95.58%) and SRTK (97.84%). Although the inhomogeneity is high for the other 3 samples, the colour differences between the most frequent colour identified on each entire sample and its calculated average colour are small (Table 1). This shows unequivocally that the identified CIELAB values represent coordinates of the colours that artists had in mind

when painting the samples. Having now unique colour coordinates for each sample, we must decide which sample should be chosen to represent the colour name “Khiao Tong On”. The obtained CIELAB values are compared across the 6 samples using TCA’s Compare Sample Pair module. Colour differences are calculated with both 1976 and 2000 formulas. The number of calculated colour differences are a combination of 6 taken 2 at a time (15 calculations). Table 2 shows ΔE_{00} calculated for the 15 combinations of pairs established from the 6 samples.

Table 2. Colour differences between artists’ sample pairs.

Pairs	CRS-CH	C R S - NTRRD	CRS-KTS	C R S - SRTK	CRS-YP	KTS-CH	K T S - NTRRD	K T S - SRTK	KTS-YP	S R T K - CH	S R T K - NTRRD	SRTK-YP	YP-CH	Y P - NTRRD	NTRRD- CH
ΔE_{00}	8.51	9.57	16.09	14.97	9.76	9.08	7.35	9.19	7.44	12.16	11.28	9.87	2.7	3.02	2.28

As can be seen in Table 2, the smallest colour differences are between YP and CH, YP and NTRRD, NTRRD and CH, last 3 values. We group YP, CH and NTRRD together and calculate the average CIELAB values among them: $L^*=74.92$, $a^*=-19.63$ and $b^*=36.30$. The group contains 2 highly inhomogenous samples: YP and NTRRD. These CIELAB values are associated to a virtual sample that we note “AV”. TCA can match this virtual sample through its Trichromatic Colour Matching module using the digitized colour dictionaries implemented in the system, Munsell and NCS being only two of them. Alternatively it can choose a “representative sample” for this colour name, based on the smallest colour difference of each selected artists’ sample towards “AV”. Closest to “AV” is CH at 1.32 ΔE_{00} units, for which TCA finds the NCS match S2040-G50Y at a colour difference of 1.45 ΔE_{00} units. The match can be visually confirmed by observers under D65 light source.

ACKNOWLEDGEMENTS

NCS – Natural Colour System property of and used on license from NCS Colour AB, Stockholm 2012. References to NCS in this publication are used with permission from the NCS Colour AB.

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