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Recognition of Paintings Using Color Data Analysis

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Abstract: Color technology and color measurement will be allow encode the color of a painting, which is a tangible cultural heritage, and create a color database based on the color measurement values. When move the painting from the premises to international and domestic exhibitions, we can compare to the previous color measurement value and last color measurement value by color data processing of painting using the color database, data analysis and machine learning to verify the original image intended. The aim of this work was to implement a method of recognizing paintings using a data analysis and machine learning methods based on color data. Data analysis methods such as spectral curve testing, distribution testing, hypothesis testing, T, F, Z testing, and ANOVA testing were tested and the results need to be confirmed by further measurements.

Key words: Color measurement, data analysis, statistical test

1. Introduction

We created a color database by making color measurements on five unique historical and cultural heritages of the Mongolian Art Gallery such as Azarganii notsoldoon, Ajliin daraa, Lenin bagsh, Uvgun huurch, Taliin ail and experimented with color data on several paintings as an example. The color data of these unique historical and cultural paintings was encoded in two different methods with a colorimeter to create a color database of paintings. The color data analysis methods that we developed using this database, it will be possible to determine whether a painting is original or damaged by comparing it with measurements before and after the painting is sent to the exhibition. This research is very important to introduce data analysis methodologies in the field of cultural heritage.

2. Research materials and data

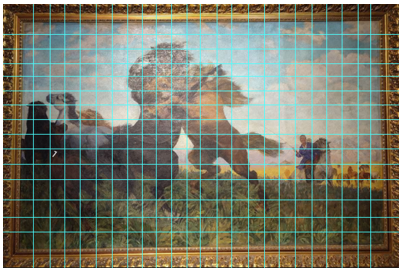

Figure 1: Painting Azarganii notsoldoon.

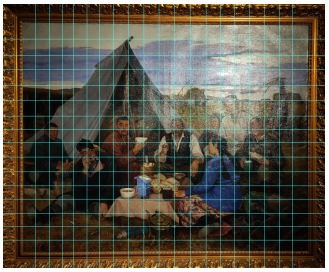

Figure 2: Painting Ajliin daraa.

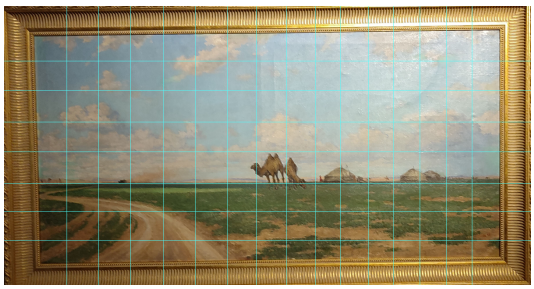

Figure 3: Painting Taliin ail.

Figure 4: Painting Lenin bagsh.

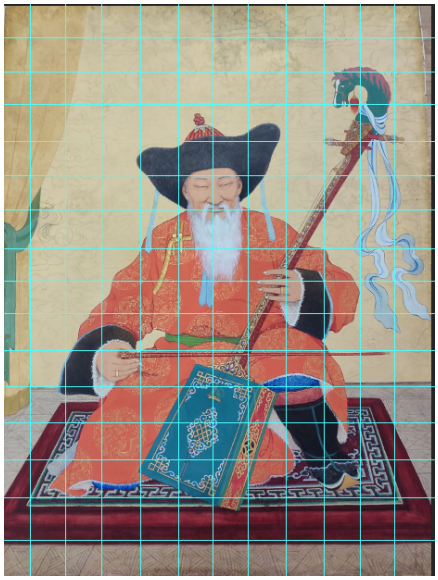

Figure 5: Painting Uvgun huurch.

3. Methodology

General methods of paintings recognition:

- Measure the color data of the paintings by above two methods,
- Create a color database,
- Make the descriptive analysis,
- Compare statistical parameters with the before and after measurement of paintings.

Methods for analyze color measurement data:

- Analyze by spectral curve method,
- Analyze by distribution histogram,
- Analyze the hypothesis test with T, F, Z,
- Analyze with ANOVA test.

We performed the color measurement in two methods.

- Measurement method 1: Measure by color and object
- Measurement method 2: Create a color matrix depending on the size

Data size information:

- Total measurements: 1752
- One measurement number of back values: 40
- Total numerical values of measurements: 70080

Table 1: Measurement amount.

Painting name	matrix	object
Ajliin daraa	285	290
Taliin ail	205	60
Azarganii notsoldoon	322	130
Lenin bagsh	165	120
Uvgun huurch	165	110
Total	1042	710

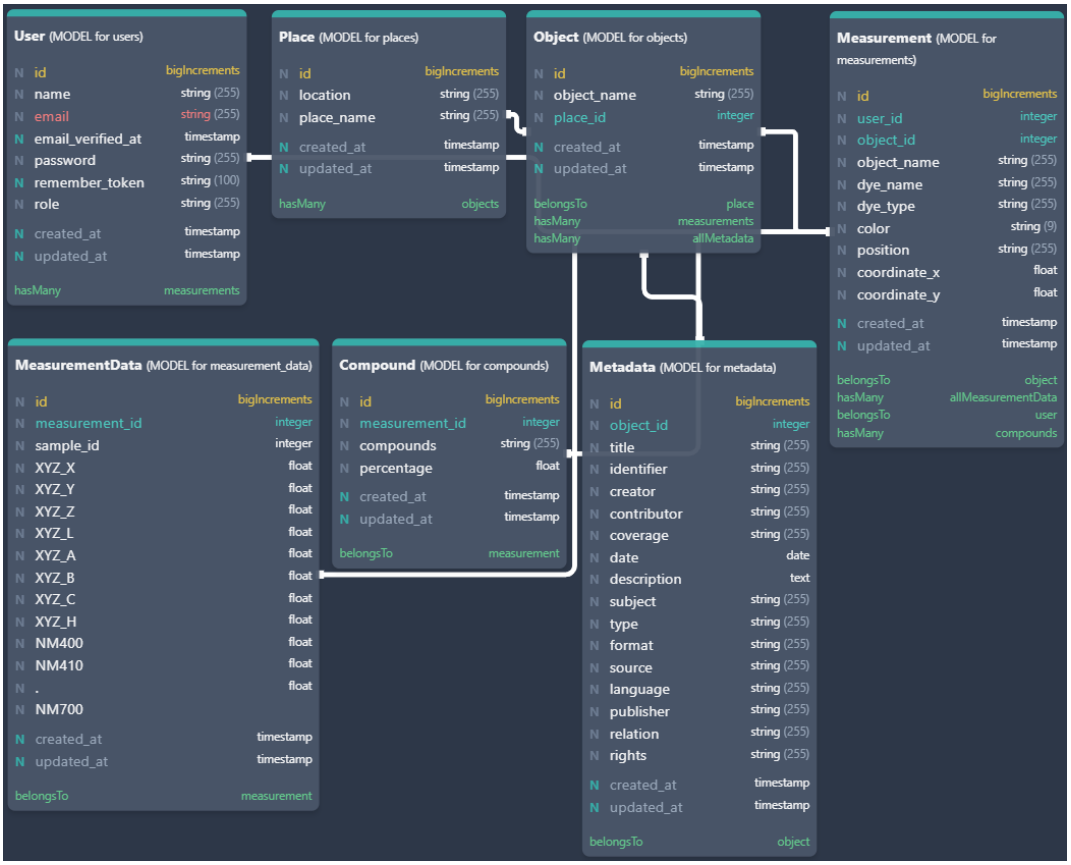

Figure 6: Structure of color database.

4. The results

In this study, a comprehensive data analysis of the above 5 paintings was performed, and four types of data analysis methods were experimented using the general methods described in the materials and methods section. In this research, the paintings are analyzed with examples of each of the above methods. In Table 2, we see that the P value is less than 0.05 and the t stat is -2.00507, which is much lower than critical level. This means that in a hypothesis testing analysis, the zero hypothesis rejects (H0) and the opposite hypothesis (H1) is accepted. These two values are considered incompatible.

Table 2: Descriptive analysis of 5 paintings.

№	Painting name	parameter	Max and min value	Mean	Std deviation	Correlation coefficient
1	Azarganii notsoldoon n=345	x	44.748 3.188	17.431	11.529	r(x,y)=0.9914, a=4.577, b=-43.701
		y	92.210 6.338	36.091	26.765	
		z	62.807 0.122	22.332	17.505	r(x,z)=0.6753
2	Ajliin daraa n=285	x	34.681 2.134	11.845	8.733	r(x,y)=0.9974, a=1.148, b=-1.486
		y	37.362 2.214	12.123	9.360	
		z	26.748 1.820	9.129	7.848	r(x,z)=0.9246
3	Taliin ail n=105	X	38.636 7.748	21.978	8.023	r(x,y)=0.9811, a=1.117, b=-0.7789
		Y	37.750 9.039	23.779	8.481	
		Z	28.057 4.900	17.543	8.251	r(x,z)=0.8547
4	Uvgun huurch n=165	X	61.547 4.890	39.833	16.156	r(x,y)=0.973, a=1.0597, b=-4.7075
		Y	61.245 4.950	37.501	16.631	
		Z	45,604 3.878	17.872	14.989	r(x,z)=0.6752
5	Lenin bagsh n=126	X	56.663 3.390	17.806	12.150	r(x,y)=0.9814, a=1.098, b=-2.452
		Y	58.519 3.415	17.100	12.732	
		Z	40.535 2.911	10.661	8.676	r(x,z)=0.6752

Figure 7 shows the construction of the image spectral curve of painting Ajliin daraa, and this curve is compared after overlapping two measurements, which is the most general method to check the image. In this picture, curves of B1-B19 are the measurement values at different points.

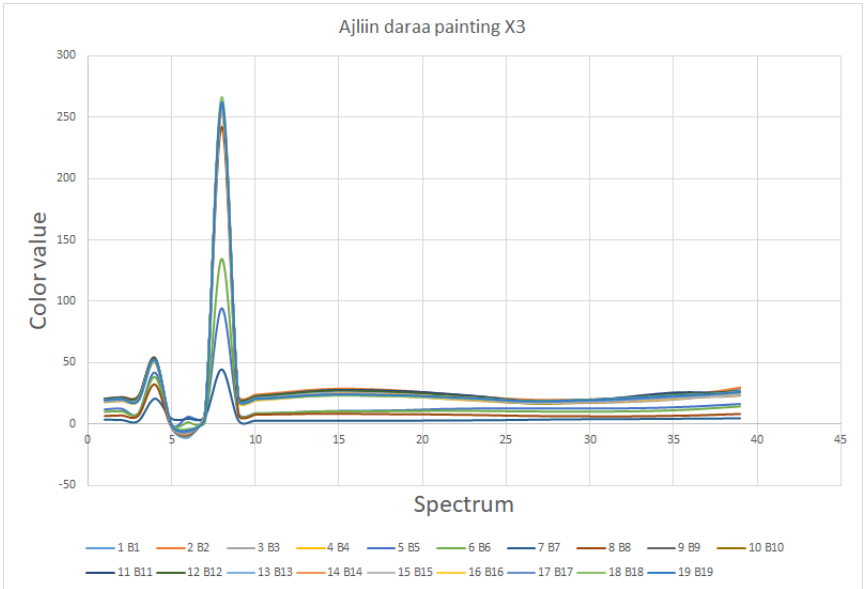

Figure 7: Spectral curve of Ajliin daraa.

The next example is the T-test, which is painting Azarganii notsoldoon with two different data In Figure 8, painting Lenin bagsh established a distribution histogram, and the two

measurements can be compared in terms of their distributions. As for the distribution, it will have different distribution depending on the painting, and the characteristics of the painting can be explained by looking at the distribution.

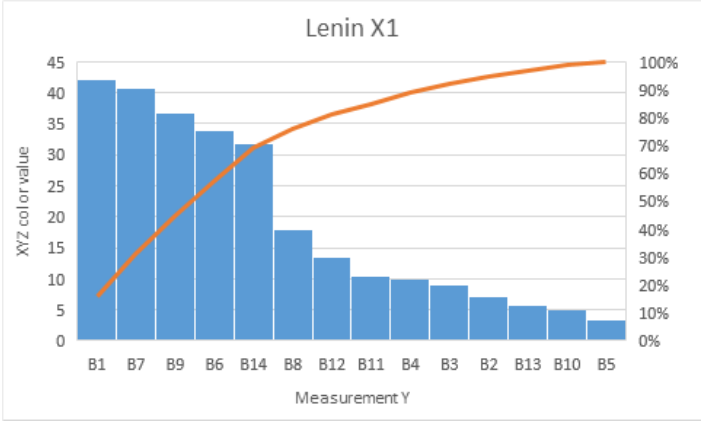

Figure 8: Distribution histogram of Lenin bagsh.

XYZ in Figure 9 represents the color value and the first table shows an example of comparing the XYZ values of 2 different measurements using hypothesis testing analysis. Here, by looking at the P and t values, we can see how different these two values are from each other.

XYZ_X	XYZ_Y
34.41458	35.06957
22.78851	27.1597
23.83805	27.6958
24.51216	26.73381
34.28044	33.84341
35.5025	35.85442
29.87264	30.30572
29.88423	31.41219
24.87744	26.89986
26.5056	28.71993
25.36265	28.91963
23.66788	27.47844
23.53827	26.76548
25.32037	29.04558
24.00142	27.5378
22.22901	25.81857
26.64402	31.52848
25.77721	29.06624
31.03245	31.30862
38.35693	38.28306
25.00795	28.94131
31.12841	31.85366
24.4763	27.17971

	XYZ_X	XYZ_Y
Mean	27.52257	29.88787
Variance	21.08288	10.92387
Observations	23	23
Pooled Variance	16.00337	
Hypothesized Mean Difference	0	
df	44	
t Stat	-2.00507	
P(T<=t) one-tail	0.025566	
t Critical one-tail	1.68023	
P(T<=t) two-tail	0.051131	
t Critical two-tail	2.015368	

Figure 9: Predictive analysis T test of Azarganii notsoldoon.

Table 3 shows the analysis of painting Taliin ail using the ANOVA test, which means that the two data are compared by variance. Using these data analysis methods, it is possible to analyze a wide range of paintings.

Table 3: Table caption.

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	169.913	9	18.87922	10.53375	1.58E-05	2.456281
Columns	218.8491	2	109.4246	61.05395	9.53E-09	3.554557
Error	32.26069	18	1.79226			
Total	421.0228	29				

5. Conclusions

We made color measurements on 5 unique historical and cultural artifacts of the Art Gallery and created a color database. In this work, experiments were conducted to introduce a method of recognizing paintings using a number of data analysis methods based on color data, and the results were explained. Testing of spectral curves, comparative testing, hypothesis testing, T, F, Z testing, and ANOVA testing has been successful and needs to be repeated the measurement. Both of these methods are possible, but if we get many points depending on the size of the image, the fastest and most comparable method is the spectral curve method. However, it is concluded that the point-by-point testing methods are more suitable if used for more detailed analysis when the measurement values are clearly deviated.

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Уран Зургийг Өнгөний Өгөгдөлд Дүн Шинжилгээ Хийн Таних нь

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Хураангуй: Өнгөний технологи буюу өнгөний хэмжилт хийж соёлын биет өв болох уран зургийн өнгийг кодлох боломжтой бөгөөд тухайн өнгөний хэмжилтийн утгуудаар өнгөний мэдээллийн сан үүсгэнэ. Уран зурагт өнгөний хэмжилт хийн өнгөний тархалтын загвар боловсруулснаар тухайн өнгөний мэдээллийн сангаа ашиглан уран зургийг олон улс болон дотоодын үзэсгэлэнд явуулах хэлбэрээр байрнаас хөдөлгөх зэрэгт дахин хэмжилт хийж өмнөх хэмжилтийн утгатай харьцуулан өнгөний өгөгдлийн боловсруулалт хийх, өгөгдлийн дүн шинжилгээ хийх аргаар тухайн эх зураг мөн эсэхийг шалгах зорилготой. Бид Уран зургийн галерейн түүх соёлын хосгүй үнэт 5 бүтээл дээр өнгөний хэмжилтүүд хийн өнгөний мэдээллийн сан бий болгосон бөгөөд энэхүү ажлаар жишээ болгон хэд хэдэн зураг дээр хийсэн хэмжилтээр туршилт шинжилгээ хийсэн. Энэхүү ажлаар өнгөний өгөгдөлд суурилан өгөгдлийн шинжилгээний хэд хэдэн анализын аргаар уран зургийг таних арга зүй нэвтрүүлэхээр зориж туршилтууд хийж үр дүн гаргав. Спектрийн муруйн аргаар шалгах, Тархалтаар нь харьцуулж шалгах, Таамаглал шалгах T, F, Z шинжүүрээр шалгах, ANOVA шинжүүрээр шалгах зэрэг өгөгдлийн анализын аргуудыг туршсан бөгөөд цаашид давтан хэмжилтээр үр дүнгүүдээ бататгах шаардлагатай юм.

Түлхүүр үгс: Өнгөний хэмжилт, өгөгдлийн шинжилгээ, статистик шалгуур