

Study on The Color Feature of Harajuku-type Kawaii Fashion Comparison with Street Snap Images Using Colorfulness

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Abstract

This research focuses on Harajuku-type Kawaii fashion style. Based on the fashion experience of the second author, we made the hypothesis that Harajuku-type Kawaii fashion contains high saturation and a large variety of color. In this work, we objectively tested these hypotheses by preparing original data sets of 3 styles: Harajuku-type Kawaii fashion, Harajuku Street snaps, and Shibuya Street snaps. We calculate saturation and employ colorfulness to quantify the variety of colors. The data sets were selected and properly modified based on heuristic rules according to the fashion experience so that each data set contains only images with typical features of its style. From the data analysis, we found that the saturation and colorfulness of Harajuku-type Kawaii fashion is statistically higher than the other two data sets. As a result, we successfully verified that Harajuku-type Kawaii fashion is very distinct in its saturation and colorfulness with statistical evidence.

Keywords: Harajuku-type Kawaii fashion, Fashion images, Colorfulness

I. INTRODUCTION

Since Japan's Ministry of Foreign Affairs (MOFA) appointed "Kawaii Ambassadors" in 2009 to promote the understanding and propagation of Japanese pop culture around the world, "Kawaii" was officially recognized and used as a foreign policy tool. Kawaii concept attracts attention and has made a large impact around the world, not only in aesthetic [1] or entertainment but also in areas like system design and engineering [2], affective engineering [3] and so on. Although Kawaii research in various fields of study has been increasing, little attention has been paid to fashion. This is contradicting to the recent fashion industry trend. In this study, our target is the fashion for adult female in Tokyo aiming at the contribution to the fashion industry. The second author has investigated the transition of Kawaii fashion trends in Japan. She found that the current "Kawaii" fashion in Japan that is well known both domestically and internationally is found to originate from the street fashion at Harajuku [4].

The fashion at Harajuku is well known for Harajuku Kawaii, which was originally termed and spread internationally by Masuda Sebastian [5]. Masuda is an artist and a producer of a Japanese pop singer, Kyary Pamyu Pamyu, one of Japan's biggest pop stars and an eccentric princess of Harajuku fashion. Kyary's Kawaii style is characterized by the presence of something a little weird or a little grotesque, the mix of disparate elements which at first glance may seem contradictory, but in reality, are not [6]. Pigtails, oversized ribbons, colorful items, gothic fantasy elements-imagery like skulls and crossbones, eyeballs, blood, and studded clothing are often used in her fashion decoration or music videos [7]-[8].

As for examples including similar expression of the fashion at Harajuku, we can observe the work by Japanese finalist in the 2016 international fashion

contest [9] or the award-winning work from international and practical contest [10]. Those works contain combinations of colors and design which we had never seen before. Also, according to the book about the worldwide view on Kawaii fashion by Sakurai [11], the evaluation of "KAWAII" value must include "Japanese-like, Tokyo-like nuance, and Harajuku fashion is known as Kawaii for girls worldwide.

Given these backgrounds, the second author began her research on Kawaii fashion at Harajuku. She investigated Harajuku street fashion and found that the fashion at Harajuku can be further classified into two types; the Lolita fashion and the otherwise [4]. The Lolita fashion was developed with the motif of European Baroque style and Rococo style, often feature clothing with frills and laces, decorated with many girly accessories [12]. Apart from the Lolita fashion is a kind of fashion that create somehow an impression of disorganized Pop-style by destroying all fashion rules. This style was named as Harajuku-type Kawaii fashion [13]. Harajuku-type Kawaii fashion style does not include only clothing in consideration but also accessories, hairstyle or makeups. An example of Harajuku-type Kawaii fashion style is shown in figure 1.



Figure 1 *Harajuku-type Kawaii fashion style*. The photo is a derivative of "IMG_2680" by Dennis A. Amith (source <https://www.flickr.com/photos/kndynt2099/16563647067/>), JI-ENT, used under CC BY-NC 2.0 / Cropped from original.



Figure 2 Example of images in Harajuku Street snaps and Shibuya Street snaps data sets.

We collected fashion images that represent Harajuku-type Kawaii fashion and analyzed the images. The analysis results were summarized based on individual fashion items including hairstyles and overall look in [13]. As for individual fashion items, we found that hair colors were often characterized by unusual and flashy impressions. Their clothes, accessories, bags, socks, and shoes all had unique designs. Clothing colors were vivid, fluorescent, or multi colors. Materials were translucent and glittery laminated. Since colors and materials were individually unique, avant-garde and weird items could be observed. Kitsch and Surreal impressions which people hesitate to use in general were adopted. On the other hand, from the overall look, we observed the “mixed style” created by multiple or unique colors, materials, items, and impressions. Even employing bad taste elements, Harajuku-type Kawaii fashion could be sublimated as more creative and different from the ordinary fashion style.

The above analysis was made by the second author, who has a rich experience in fashion. Although there are many elements of fashion such as colors, materials, items, we focus only on color in this paper. To statistically verify these results, we made the following hypotheses regarding Harajuku-type Kawaii fashion.

- Harajuku-type Kawaii fashion contains high saturation clothing [14].

- Harajuku-type Kawaii fashion contains large variety of color combinations.

In this paper, we will statistically prove these hypotheses by data collection, data preprocessing, and then analysis using saturation and colorfulness. Colorfulness [15] is a perceptually based metric obtained by fitting the calculation parameters to the results of psychophysical category scaling experiment. It is used for image quality assessment, such as quality evaluation after image compression [16]-[18]. To prove the second hypothesis, we used colorfulness as an image quantitative feature to represent a variety of colors. No research has used it for this purpose before.

II. DATA PREPARATION

A. Data Collection

Fashion images were collected for the following data sets:

- Harajuku-type Kawaii fashion
- Harajuku Street snaps
- Shibuya Street snaps.

Image collection for each data sets was carried out by Japanese female students enrolled in the Department of Textile and Clothing, Faculty of Home Economics, Kyoritsu Women’s University. These students were educated on fashion design and had extensive knowledge and personal interest in fashion. They also have part-time jobs in the fashion industry.

	Top 3			Middle 3			Bottom 3		
Harajuku Street snaps									
Colorfulness	84.14	78.57	72.61	31.14	29.00	28.44	18.69	17.56	16.33
Shibuya Street snaps									
Colorfulness	60.84	57.93	44.16	25.03	24.20	23.45	18.81	18.25	17.32

Figure 3 Preprocessed images from original images in Harajuku and Shibuya Street snaps data sets shown in figure 4, with colorfulness values. The table shows images with top three, middle three, and bottom three colorfulness within the data set accordingly. Images collected for Harajuku-type Kawaii fashion cannot be included in the publication due to Instagram copyright.

They have studied the second author’s research and understand Harajuku-type Kawaii fashion with their own sense. The selected images were verified their appropriateness according to the second author’s experience. Therefore, the data set contains only the images that represent each style’s characteristic. The characteristics of Harajuku-type Kawaii fashion are vivid, fluorescent and multicolor, with a mixture of Kitsch and Surreal impressions [13] as described in the introduction (Section 1).

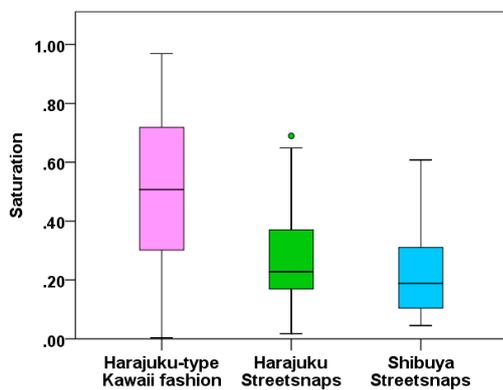


Figure 4 The boxplot comparison of saturation values of the 1st dominant color for each fashion styles [14].

Images for Harajuku-type Kawaii fashion data set were selected from influencer’s Instagram™ account. Due to the copyright restriction of Instagram™, the example of Harajuku-type Kawaii fashion data sets cannot be shown in this manuscript. We can only introduce figure 1 and figure 5 to show information related to Harajuku-type Kawaii fashion data set instead. We chose the images for each data set of Harajuku Street snaps and Shibuya Street snaps from the website of Style-arena.jp. However, to choose the data set of those two street snaps can possibly ambiguous because Harajuku and Shibuya are close to each other. Figure 2 shows an example of collected images for Harajuku and Shibuya Street snaps data set.

B. Data Preprocessing

The collected images have various backgrounds, which could interfere with the analysis, as seen in figure 2. Therefore, it is necessary to remove the background before proceeding to data analysis.

A regular RGB image contains 24 bits value pixel information (R, G, B channel). To discard all pixels that represent background. We employ 32 bits image that

Harajuku-type Kawaii fashion (N=61)		Harajuku Street snaps (N=41)		Shibuya Street snaps (N=20)	
Order	Top 8 th Dominant colors	Order	Top 8 th Dominant colors	Order	Top 8 th Dominant colors
1		1		1	
2		2		2	
3		3		3	
30		19		9	
31		20		10	
32		21		11	
59		39		18	
60		40		19	
61		41		20	

Figure 5 Example of top 8th dominant colors extracted from nine example images in Harajuku-type Kawaii fashion, Harajuku Street snaps, and Shibuya Street snaps data set [14]. The table shows the image's order number, sorted from the highest saturation value to the lowest saturation value of the 1st dominant color, with the top 8th dominant colors shown in a color bar of that image respectively. The different color width in the color bar represents the ratio.

can represent the pixel value as 4 channels; RGBA, where A represents an Alpha value. An alpha channel contains a pixel's transparency information.

For data preprocessing, we semi-automatically segment each image using Photoshop™. The image data was re-written in 32-bits .PNG file format to contain an alpha channel. The alpha channel contains only 1 or 0 as the indication for foreground or background region in the image. Figure 3 shows the preprocessed images from the collected images for Harajuku and Shibuya Street snaps in figure 2.

III. FIRST HYPOTHESIS

Regarding the first hypothesis, we introduce our previous work [14], which was done around 6 months before proving the second hypothesis. We employed the method consisting of data collection, data preprocessing, and data analysis. We collect images for data set as follows;

- Harajuku-type Kawaii fashion (N=61)
- Harajuku Street snaps (N=41)
- Shibuya Street snaps (N=20).

For data analysis, we extract the saturation from each image in the data set. Saturation defines the brilliance and intensity of a color. High saturation colors look rich and full while low saturation colors look dull and grayish. For each image, we performed a conversion from RGB to HSV representation. Then, we performed color quantization to reduce the number of colors to 72 and created a histogram with 72 bins. The values of the histogram were normalized in each image. After that, we sorted the histogram in the decreasing order. The colors in the first eight bins were the eight dominant colors of that image. Figure 4 shows the boxplot comparison of the saturation value of the 1st dominant color for each data set. We further show eight dominant colors from images that have the top three, middle three and bottom three saturation value of the 1st dominant color in figure 5. The eight dominant

Table 1 Min and max saturation values of the 1st dominant color for all images.

	Harajuku Kawaii	Harajuku Streetsnap	Shibuya Streetsnap
Min	0.0039	0.0177	0.045
Max	0.9691	0.6896	0.6079

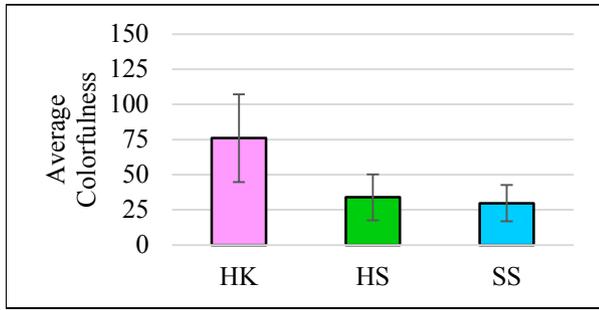


Figure 6 The comparison of the average colorfulness for Harajuku-type Kawaii fashion (HK), Harajuku Street snaps (HS), and Shibuya Street snaps (SS)

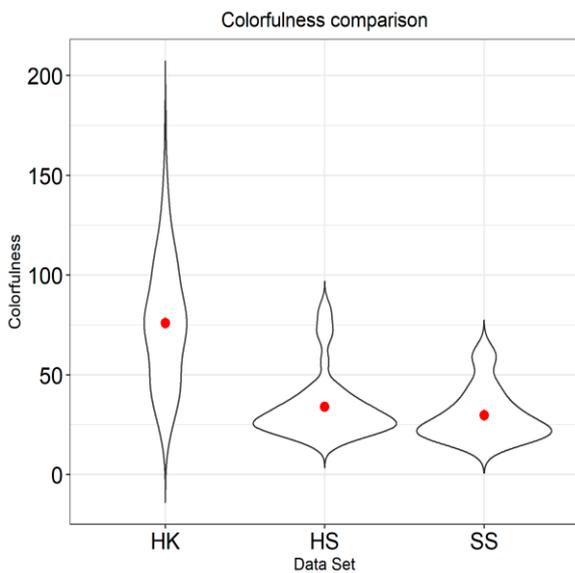


Figure 7 Violin plot for comparison of the distributions of colorfulness between data sets

Table 2 Min and max colorfulness values for all images.

	Harajuku Kawaii	Harajuku Streetsnap	Shibuya Streetsnap
Min	18.89	16.33	17.32
Max	174.50	84.14	60.84

colors are shown in color bars with interval width as a ratio. Also, the min-max saturation values of the 1st dominant color for each data set are shown in table 1. From the analysis, we found that Harajuku-type Kawaii fashion contains significantly highest saturation, followed by the Harajuku Street snaps and Shibuya Street snaps accordingly.

IV. SECOND HYPOTHESIS

Table 3 The correspondence between the colorfulness attributes and the value of C [9].

No.	Attribute	Value of C
1	Not colorful	>0
2	Slightly colorful	>15
3	Moderately colorful	>33
4	Average colorful	>45
5	Quite colorful	>59
6	Highly colorful	>82
7	Extremely colorful	>109

Table 4 The ratio of images in each data set classified into each colorfulness attribute.

No.	Ratio of images in the data set (%)		
	Harajuku-type Kawaii fashion	Harajuku Street Snaps	Shibuya Street Snaps
1	0.0	0.0	0.0
2	6.2	65.9	70.0
3	14.2	22.0	20.0
4	12.4	2.4	5.0
5	27.4	7.3	5.0
6	24.8	2.4	0.0
7	15.0	0.0	0.0

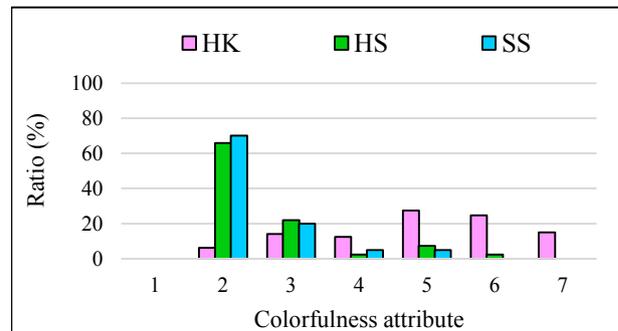


Figure 8 The chart shows ratio (%) of images classified into each colorfulness attribute.

A. Background

To prove the second hypothesis, we employ the colorfulness proposed by Hasler and Süssstrunk [15]. The colorfulness can be calculated by defining the opponent color values using Equations 1 and 2 with R_p , G_p , and B_p are the value in the Red, Green, and Blue channel accordingly. For each image, we calculate Equations (1) and (2) of each pixel. The results of u and v for all pixels are stored in one dimensional array accordingly.

$$u_p = R_p - G_p \quad (1)$$

$$v_p = \frac{1}{2}(R_p + G_p) - B_p \quad (2)$$

Then, μ_{uv} and σ_{uv} are computed using Equations (3) and (4). In the equations, μ_u and σ_u are the mean and the standard deviation of u_p , while, μ_v and σ_v are the mean and the standard deviation of v_p . Equation (5) shows the calculation of the final colorfulness: C .

$$\mu_{uv} = \sqrt{\mu_u^2 + \mu_v^2} \quad (3)$$

$$\sigma_{uv} = \sqrt{\sigma_u^2 + \sigma_v^2} \quad (4)$$

$$C = \sigma_{uv} + \alpha \cdot \mu_{uv} \quad (5)$$

We use $\alpha = 0.3$ in our work similar to Hasler and Süssstrunk [15].

B. Data Analysis

We employ data collection and data preparation as described above in Section II (Data Preparation). The number of the images for Harajuku-Kawaii type fashion used in the study to test the second hypothesis was larger than that used in the study to test the first hypothesis because the former study was performed 6 months later than the latter, and we continued to collect images during that. Therefore, we increased the number of images that represent Harajuku-Kawaii type fashion to N=113. Harajuku Street snaps and Shibuya Street snaps data sets are the same as before.

We computed the colorfulness, C , for every preprocessed fashion image in each data set. The high colorfulness value indicates that the fashion image contains a variety of colors.

Figure 3 shows the preprocessed images of Harajuku and Shibuya Street snaps data set and the corresponding colorfulness. The min-max colorfulness values for each data set are shown in table 2.

A one-way ANOVA was conducted to determine if the colorfulness was different across data sets. There were no outliers, and the data were normally distributed for all data sets. A significant main effect was found (Welch's $F(2, 68.758)=77.787, p<0.001$).

Figure 6 shows the averages and standard deviation for Harajuku-type Kawaii fashion (HK, $\mu_{HK} = 75.99, \sigma_{HK} = 31.3$), Harajuku Street snaps (HS, $\mu_{HS} = 33.98, \sigma_{HS} = 16.33$) and Shibuya Street snaps (SS, $\mu_{SS} = 29.76, \sigma_{SS} = 12.94$). From the graph, HK has the highest colorfulness among all data sets, followed by HS and SS accordingly.

Games-Howell post hoc analysis revealed the main significant difference between HK and HS ($p<0.001$), and between HK and SS ($p<0.001$). However, there is no significant difference between HS and SS. These analysis results showed that although HK and HS can be observed in Harajuku, the colorfulness of HK is significantly higher than that of HS. Meanwhile, the colorfulness of HS and SS are similar.

Figure 7 shows density or violin plots of colorfulness of each data set. The red dots show the mean of colorfulness. The width of the area at each level of colorfulness shows the ratio of images in each data set. It can be seen from the figure that the colorfulness of HS and SS gathers around the averages, whereas the colorfulness of HK spreads in a wide range and the thickest section is not as large as the others. From the figure, the distribution of colorfulness in HK is totally different from HS and SS, while HS and SS are similar.

Hasler and Süssstrunk defined the correspondence between the value of C and the colorfulness attributes in [15], and we show them in table 3. We show the ratios of images for each colorfulness attribute in table 4 and figure 8, where the ratio was employed due to the difference in the total number of images in each data set. It can be seen from the figure that most images in HK are classified as "Quite colorful," "Highly



colorful,” and “Extremely colorful” accordingly. Meanwhile, the colorfulness of images in HS and SS are mostly classified as “Slightly colorful.” Images in HK are apparently categorized in higher categories compared to images in HS and SS, while images in HS and SS are similarly categorized.

V. DISCUSSION

In our research, there are novelties in data collection and data analysis described as follows:

The second author, an expert of fashion, selected only images of typical Harajuku-type kawaii fashion to build the data set. This data set is new because there are no Harajuku-type kawaii fashion data set with similar quality before. Inputting “Harajuku-type Kawaii fashion” as a word in a search engine, many images should be shown. However, if we employ those images for analysis, no significant result will be obtained because of the low quality of the data set as Harajuku-type kawaii fashion data set.

The comparison of colorfulness values showed that HK contain high variety, while HS and SS is similar. This finding is also supported by the distribution shape observed from figure 8. This is a new finding because no one statistically verified that Harajuku-type kawaii and Harajuku Street Snap are very different even they are in the same location.

The colorfulness value could result from all cases as follows

- An independent fashion item has each different color.
- Mix and match of different single-color fashion items.
- The combination of both.

High colorfulness is caused by any cases, which case does not matter because Harajuku-type Kawaii fashion includes all of the above cases [4], [13]. Hence, the

colorfulness value shows the difference between Harajuku-type Kawaii fashion from other fashion styles.

Besides, if the simple colorfulness value of a fashion image is high, there is a possibility that the fashion might be messy. However, our data set contains only the images of typical Harajuku-type Kawaii fashion, so there are no messy clothes.

In this research, we compared Harajuku-type Kawaii fashion to only Harajuku Street snaps, and Shibuya Street snaps because the fashion at other locations, such as Ginza, Omote Sando and Daikanyama are apparently different from those three, as they are classified as luxurious, modern and high-end [19]-[20], which are far from Harajuku-type Kawaii fashion.

Our proposed methods can be applied to other fashion styles as well. For example, to objectively define the distinctiveness of colorful scarf patterns of Hermes and Emilio Pucci from other high-end brands. Moreover, the colorfulness range could be used as a reference when designing a new pattern for those particular brands.

VI. CONCLUSION

Kawaii concept is used to promote the understanding and propagation of Japanese pop culture around the world. Although there is much research on Kawaii in various field, little research has been conducted regarding Kawaii fashion. The second author investigated the transition of Kawaii fashion trends in Japan and found that they were originated from the street fashion at Harajuku, which can be grouped into the Lolita fashion and the Harajuku-type Kawaii fashion [4].

We made two hypotheses that Harajuku-type Kawaii fashion contains high saturation and large variety of color combinations. We successfully verified them with our proposed method of data collection, data

preparation, and statistical data analysis using saturation and colorfulness.

Our proposed method can be applied not only for Harajuku-type Kawaii fashion analysis but also to other fashion styles, or other purposes as well. This study focused only color and found an interesting feature of Harajuku-type Kawaii Fashion. In future, data collection could be more systematic to contain more images.

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