

# Color Scheme Simulation for the Design of Character Groups

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**Abstract.** Characters in visual contents are as important as the script in the initial production phase. A Design Engine was proposed to improve the efficiency of character development by providing aid in the planning phase, where character blueprints are drawn based on literal information provided by the producer. Many existing methods for creating color schemes cannot be applied to character design. We proposed a design method using a color scheme simulation system for one character at the time. This paper aims to provide a character color scheme support system using a color scheme scrapbook containing color palettes of existing characters. This is a part of the Design Engine for character making with literal information. The concept of a Digital Scrapbook is to set up a personal database in a computer that will help producers and directors to pin down the appearance or looks of the character they want their designers to sketch.

*Key Words:* CG, color scheme, character groups, scrapbook, design support system  
*MSC 2010:* 68U05

## 1. Introduction

Individuals have come to be able to produce animation content by themselves due to the development and spread of high-performance software and low price computers. Animations contain the same elements of story, characters, and direction as movies do. Further, characters leads to good opportunities for deploying in advertising and merchandise. In order to create these characters, the colors, costumes, modeling, etc. must be determined for reflecting and work together with background and story. These design steps are performed at the stage of pre-production. Pre-production is the stage for “Planning”, “Scenario”, “Design”, “Settings” and “Storyboards” in video production [5].

Software and tools of various production supports have been developed in accordance with the digitization of the production process. However, many of these are for supporting the production stage. For this reason, the current state of characters at the production stage relies solely on the sense of illustrators and production staff. Therefore, illustrators and production staff have been producing using their own experience and sense which is stored in a database in the brain. For this reason, they are preparing a database in the brain. By digitalizing these processes, it becomes easier for creators to share and reuse color palettes, costumes, and modeling that reflects a certain background or story of a work. One support system for creating conventional color schemes uses a method that automatically changes the color scheme of a work by using color design techniques [6]. Other coloring support systems have also been proposed, such as systems for presenting a color scheme example to suit the preference of the operator by learning worker scheme tendency (color arrangement position and area ratio) by using a genetic algorithm [7]. However, for a character, there are the appearance features and the inner surface features, a color scheme is a major factor to change the impression [4].

When creating a color scheme for an inter alia human-type character, with a set of limited skin, hair, and eye colors, it is difficult to create it in accordance with the laws of color using systems of previous studies [2, 3, 6, 7]. In addition, when creating human-type characters for animation, it is necessary to determine the color scheme of the characters in consideration to a combination of fashion elements and art elements. Due to these factors, it is difficult to create color schemes for character design. The color scheme for letting it look more attractive, is mostly entrusted to illustrators and empirical rules and senses of animators. Also, in animation contents, individual characters appear and form each group. It is necessary that it is possible to differentiate each character and give them attractive appearance characteristics and inner surface features.

However, it is not easy to give different and attractive characteristics to all characters. The production of a color scheme is a time consuming process and it takes much effort to color the numerous versions that are needed for the many interactions between the illustrator

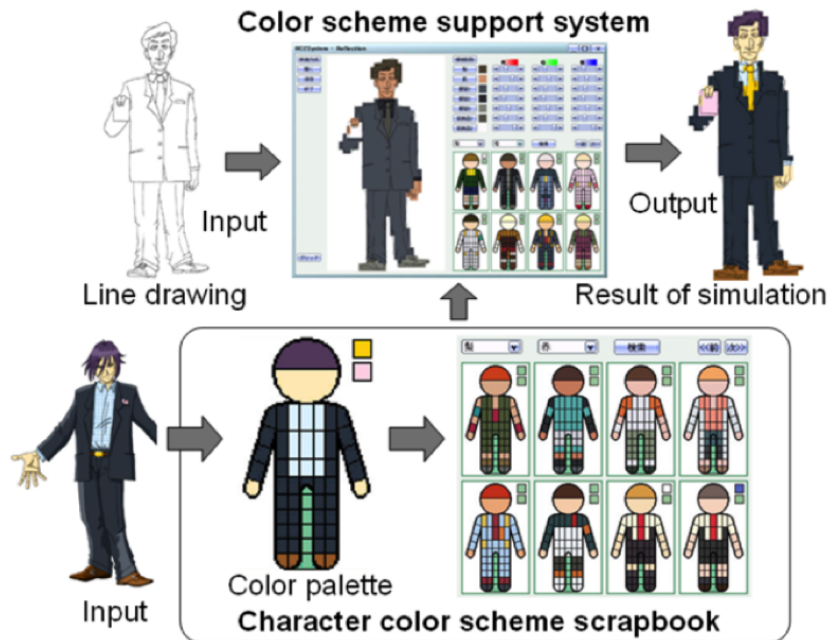


Figure 1: Color scheme support system

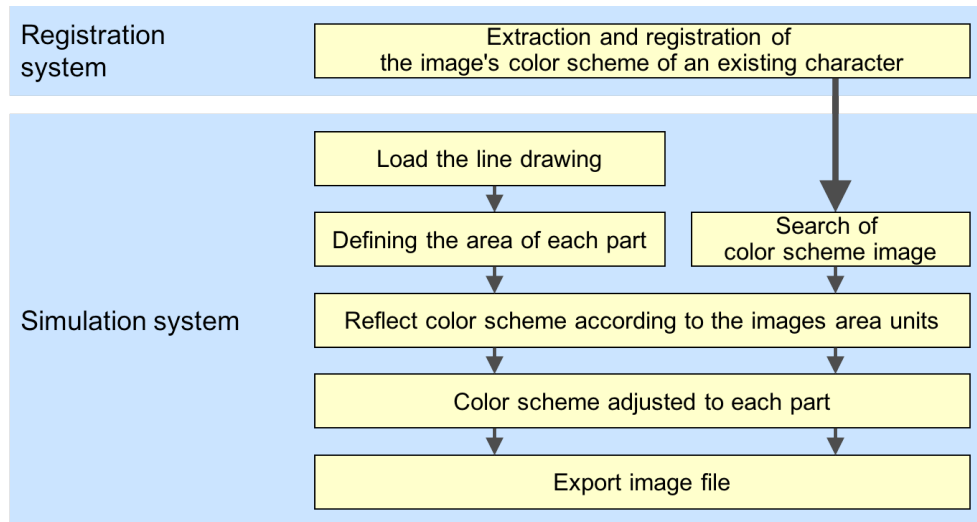


Figure 2: Process of support system

and the producer. Therefore, in this study, the focus is placed on color schemes for character groups, for supporting the process of creating attractive characteristics for characters that works well together. Thus, a color scheme design method using color scheme simulation for character groups was developed.

## 2. Conventional methods

In [4] MOTEGI et al. conducted a study for creating a color scheme support system for character design. The purpose of this study was to create a color scheme simulation system that can give support during production. The authors developed a color scheme scrapbook for color scheme simulation [4] and a coloring support system using this color scheme scrapbook. An overview of the system can be seen in Figure 1, and the procedure of color simulation is shown in Figure 2.

In addition, SAKAUCHI et al. carried out the development of a production support scrapbook for the design of the character groups [8]. In this study, for the purpose of creating the proposed method of collective character design, a survey of existing works dealing with character groups was conducted. A scrapbook could then be created by classifying the character groups.

## 3. Investigation of existing characters

In order to simulate the coloring of group characters, we conducted surveys of group setting of existing works and coloring information. The same color information of a single character needs to be obtained in any condition. Therefore, color scheme information of the character group was extracted with the following two conditions.

1. Animation works, that have been created in 2DCG.
2. Works created in 3DCG.

In addition, characters investigated in this study were limited to “human” and “similar to humans”. In addition, hand-painted digital data were not included since the texture effects the color in a way that the sample result will differ every time. In this study we sampled 203 characters from 27 works.

### 3.1. Investigation of color scheme

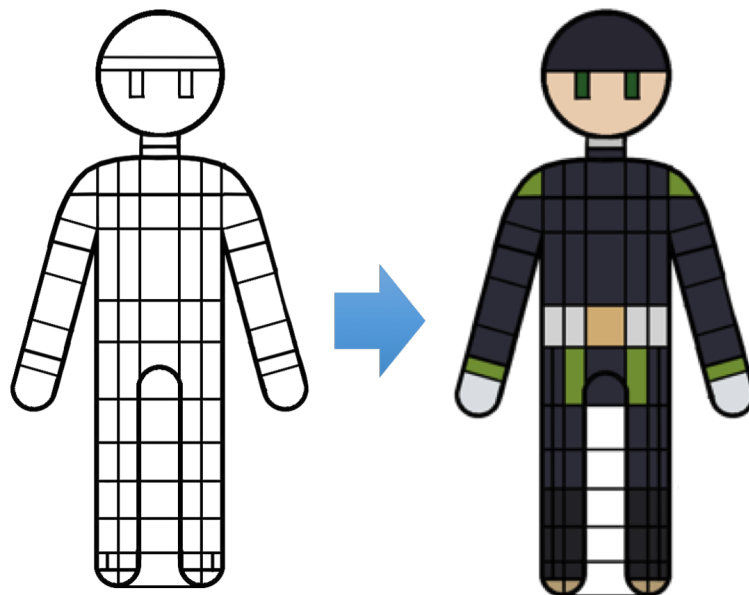


Figure 3: Color scheme template

We classified each part of the character body in order to study the color information of existing characters. When extracting the color arrangement information, the used character images were taken from the official websites for animation and 3DCG works. In the previous study by MOTEGI et al. a template containing 58 areas of color sampling was created [1]. However, this template was insufficient for reproducing the color scheme information, since there were no regions corresponding to areas such as neck or wrist. Therefore, based on the result of this investigation, we added space for “neck”, “wrist”, “upper arm”, “toe”, and “outer coat” in the new template.

The new template is shown in Figure 3. The color scheme information extraction using the new character template can be recorded in 80 areas. The color extraction for each part was done from the base color; the part corresponding to shadows and highlights was omitted in this study. The additional data for covering parts corresponding to accessories and weapons would have been huge and were therefore omitted, as well. However, the characteristic ones,

Table 1: Investigation item

<i>Investigation item</i>	<i>Explanation</i>
Name	Character name
Sex	Sex of character
Age	Age of character
Role	7 roles of characters
Intention	The intent of the group
Number	Number of group members
Year	Production year

such as an accent color and ribbon and tie were to extract. Accordingly we were able to create a color scheme template such as the one shown in Figure 3 by investigating the color of each area and position for each single character. We were able to collect the arrangement of color information using this template.

### 3.2. Investigation of character group information

The survey parameters of each character group are shown in Table 1. Since various groups will appear in the video content, we do all the investigations using the character list. Based on the classification method by SALAUCHI et al., we classified the populations in this study [8]. The contents for the classification is shown in Table 2. For classifying the roles, the method of TSUCHIDA et al. was used [9]. Its contents are shown in Table 3. The role of the character is classified according to the role in the story rather than the role information within the character group.

Table 2: Intent of the group

<i>Name</i>	<i>Explanation</i>
Family	Blood relative, parents and child, live together
Clan	Blood relative, living together in a wide range
Childhood friend	Friends from a young age
Classmate	Belong to the same class
Club	Belong to the same school and the same club
Team	Group with the same purpose
Forces	Groups intended for combat
Traveler	Travel companions
Company	Group of company
Rival	Groups in the hostile-rivalry
Other	Groups of other

Table 3: Role type

<i>Role type</i>	<i>Explanation</i>
Protagonist	Protagonist is the central figure of the story
Collaborator	Collaborator is a person who acts together or becomes a substitute with a protagonist
Antagonist	Antagonist is the person who creates a motive in the story
Victim	Victim is the person who creates a motive in the story
Client	Client is a person who causes a change in the story
Assistant	Assistant is a person who makes a cause to change the story
Rival	The rival challenges the protagonist and disappears as a result

## 4. Analysis

In this chapter, we explain a survey that was carried out using the method specified in the previous chapter. In addition, we reveal the number of people in a group and the number of colors on the body of each character.

### 4.1. Analysis of color scheme

As a result of our investigation of the color schemes of the existing characters, the number of colors used for a character with one body ranges between 4 and 12 colors. And, 90% of the characters are composed of less than 11 colors. As breakdown of colors, from the colors used on the head, 90% of the characters are composed of three colors. The number of colors of parts other than the head (the part corresponding to the torso and legs) lies between 1 and 9 colors. 90% of the character's color schemes other than the head were composed of eight colors. We also analyzed parts of the body based on the character color scheme. The results are shown in Table 4.

### 4.2. Analysis of the number of people in the character group

When classifying the number constituting the character group, character groups were found from a minimum of two people to a maximum of fourteen people. A breakdown on the configuration for the number of people is as follows:

2 people: 36%, 3 people: 19%, four people: 13%, five people: 9%, 6 people: 10%, 7 people: 4%, 8 people: 4%, 9 people: 1%, 10 people: 1%, 12 people: 1%, 14 people: 1%. Finally, 87% of the groups contain between two and six people.

Table 4: Classification of Body Parts

<i>Upper body</i>	<i>Outerwear</i>	<i>Hip</i>	<i>Collar</i>	<i>Shirt</i>	<i>Inner</i>	
Number of characters	102	34	10	25	25	
<i>Arm</i>	<i>hand</i>	<i>shoulder</i>	<i>Armband</i>	<i>sleeve</i>		
Number of characters	9	13	4	5		
<i>Lower body</i>	<i>skirt</i>	<i>pants</i>	<i>Under toes</i>	<i>Feet</i>	<i>Skirt 2</i>	<i>Pants 2</i>
Number of characters	36	40	49	91	9	3
<i>Decoration</i>	<i>Breast</i>	<i>line</i>	<i>Tie</i>	<i>Scarf</i>	<i>O1<sup>1</sup></i>	<i>O2<sup>1</sup></i>
Number of characters	34	13	15	2	4	1

## 5. Color scheme simulation system

This chapter describes the color scheme simulation for the support of the character group color scheme. The system was built using Processing. The mechanism of the system is shown in Figure 4. This was necessary for the color scheme simulation system, the color scheme information and the collective information of the existing character group, manually registered in the XML file. 48 existing character groups have been registered with 151 character bodies.

<sup>1</sup>Ornaments

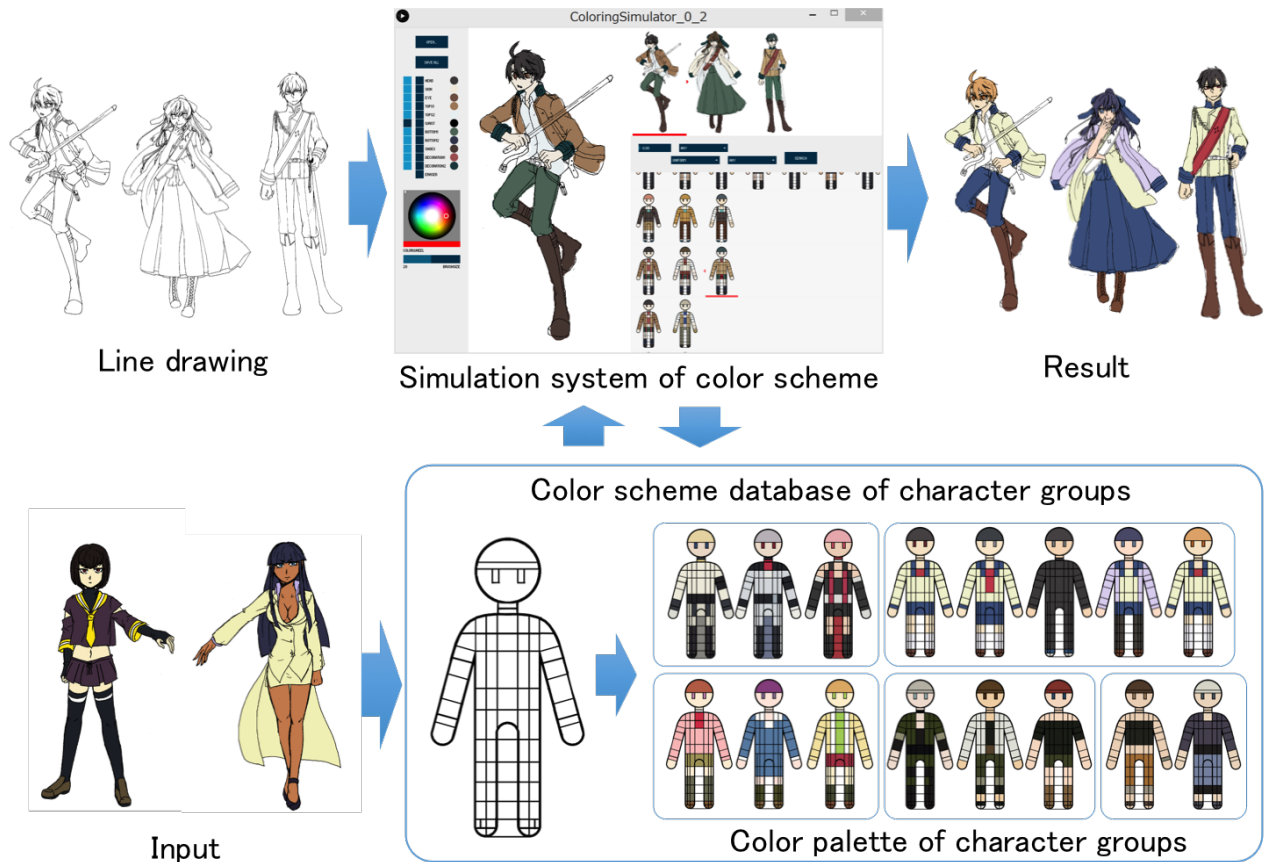


Figure 4: Overview of system

In the color scheme simulation system and the color information of the existing characters, search for the group color scheme from the works information, and simulate the color scheme. The user screen of this system is shown in Figure 5. The usage instructions follow below in items 1–4.

- 1) The user first starts the system, reads a line drawing of the collective character that he or she wants to simulate.
- 2) Using the set items of 11 body parts, specify the area to be painted for each color with respect to the read line drawing.
- 3) Then do a search that matches the intent of the collective character to create a new character's color scheme.
- 4) Select the color scheme information for an existing character; then change the color. The simulation goes until it becomes the color scheme of your choice.

After that, specify and select each of the regions from the 11 areas on a line drawing. 11 areas are composed for “Head,” “Skin,” “Eye”, “Tops 1”, “Tops 2”, “Waist”, “Bottom 1”, “Bottom 2”, “Shoes,” “Decoration 1” “Decoration 2”. The intention of the character group can be determined by selecting from the 11 items “family”, “clan”, “old friend”, “classmate”, “club”, “team”, “Forces”, “traveler”, “company”, “rival”, and “other”. The color pattern can be selected from the three items “uniform”, “squadron”, and “other”. For the movies description 13 items are available: “adventure”, “combat”, “battle”, “sport”, “school”, “club/class”, “love”, “magic”, “transform”, “Robot”, “mystery”, “evil”, and “everyday”.



Figure 5: System interface

## 6. Evaluation test

### 6.1. Purpose of the evaluation test

The purpose of an evaluation test is to confirm the efficiency of the color scheme simulation for character groups using a proposal system. The designer must consider the intention of the character groups in a character color scheme. Therefore, our system can search character scheme information using keywords of intent for the groups.

### 6.2. Experimental method

In this evaluation test we prepared line drawings and character information for the original animation. The procedure is as follows.

- 1) Participants read the plot and characters basic information. After that, participants search the color scheme information with our system.
- 2) Participants paint using the paint function of our system to character the line drawing of character groups.
- 3) Participants paint color using the existing software “Photoshop” on the line drawing of character groups.
- 4) We compared the working time of steps 2) and 3).

### 6.3. Result of evaluation test

In step 1) of this evaluation test, participants were testing three types. Type A is the search using the intent of groups. Type B is the search using the number of characters in the group. Type C is the search using the pattern of the character color.

As a result, if users of our system selected the search type depending on the most important intent of character groups, they could use a higher variety of color schemes. Furthermore, our system can paint all characters in the same group within shorter time. In this evaluation test, participants used 1 to 2 hours for painting all characters in the same group if using





Figure 6: Result of color scheme simulation for character1

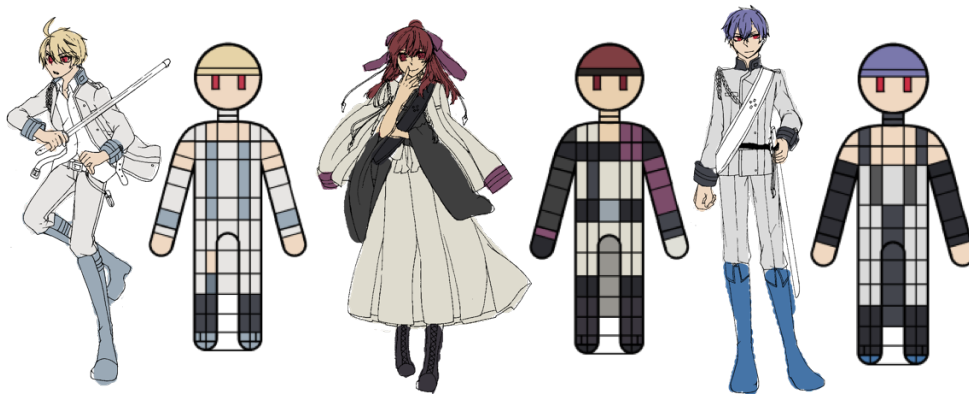


Figure 7: Result of color scheme simulation for character2



Figure 8: Result of 3 types simulation for character groups

the existing software Photoshop. However, if using our system, participants used 10 to 15 minutes for painting all characters in same group. Our system provides less labor or time for repainting because of using the color scheme database based on the analysis result on existing animation characters. Figures 6 and 7 are the result of color scheme simulation for some characters. Participants painted new characters using the color scheme of existing characters in this simulation. Figure 8 is the result of 3 types simulation for character groups. Participants painted new character groups using the color scheme of 3 type character groups.

## 7. Conclusion and future works

The purpose of this research was to support the color scheme simulation for the design of group characters in animation production. In this research, we analyzed 203 animation characters from 27 animation contents. Furthermore, we proposed a simulation system for a color scheme based on the analysis of the color scheme information of existing animation characters and character groups. In an evaluation test, we tested color schemes of character groups using a proposal system. As a result, we confirmed the efficiency of the color scheme simulation for character groups using the proposal system.

As future work for this research, we plan to automate the color scheme information registration. We registered the color scheme information for our system manually, because the number of parts and the area of parts were different for each character. Therefore, we couldn't automatically extract the color scheme information from the character image. Furthermore, our color palette is intended for men's clothes only. In many cases women's clothes have more difficult pattern than men's clothes. Therefore, our system cannot simulate color scheme for women's clothes. We think that the development of a simulation method for pattern of clothes is needed for a more advanced support of the character color scheme.

## Acknowledgements

The authors thanks MIKU IGARASHI for providing experimental line drawings and experiment cooperation.

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