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Pokemon Color Adjustments for Augmented Reality Contents

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Abstract

The methods for rendering content realistic in Augmented Reality (AR) have already been advanced, but the consideration from the context of actual users on image coloring adjustment remains to be investigated. Recent illuminant-aware content tuning algorithms focused on anticipate a more natural-looking AR contents, this paper accounts the contribution for effect of memorial color in anime character. In this circumstance, this study aims to investigate the image color adjustment on AR anime contents in living environment. In the experiment, seven designers: three were highly interested in Pokemon and the others were not were recruited to adjust the hue, saturation, and lightness of three pokemon characters in 40 different environments using Adobe Photoshop. As a result, saturation and lightness adjustments were found to be the most dominant. Also, designers with more interest in pokemon tended to make pokemon more saturated. Thus, this study demonstrated that illuminant-aware color tuning is anticipated to render AR anime contents.

Introduction

Towards an immersive AR experience, continuous devotions are being made to make AR look more realistic. Likewise, the scope of research regarding the realisticity of AR experience has already been advanced in various fields of the computer science domain as shown in Figure 1. Referring to AR kit from Apple on Figure 1 (left), demonstrates environment texturing features that create realistic rendering reflections through a mirror-finish sphere. This algorithm improving the realistic aspect of the AR, the current AR research focuses on content diversity and methods for providing information. Another example is the real time outdoor illuminant rendering of Figure 1 (right), is an accurate color estimation that follows more natural lighting adjustments for correlated color temperature in the AR environment. In the field of color science, recent studies extend research regarding synchronization of illuminant color for achieving immersive AR experience.

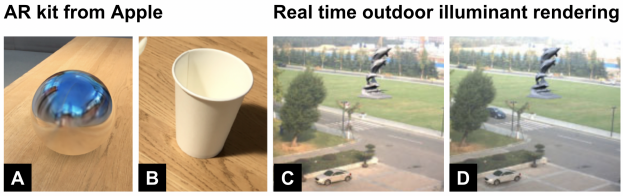

Figure 1. *Augmented Reality (AR) experience in various rendering contents. (Left) AR kit for application developers from Apple[1]. (Right) Real time outdoor illuminant rendering based on correlated color temperatures[2].*

AR media is not only composed of actual contents, but also extends to anime contents such as PokemonGo. Having an approximate monthly active user of around 150 million, Pokemon Go is one of the most leading mobile games that provides augmented gaming experience. PokemonGo, which is tied to Nintendo's best-selling anime Pokemon, is an AR-Based game that allows users to encounter and explore pokemon creatures in their real-world settings. The AR+ mode in Pokemon Go displays pokemons that are anchored to the live view of the real-world in front of the gamers. Along with the recent boom in AR, it is being manifested and extended to anime contents. Likewise, rendering of the augmented pokemon in PokemonGo is consistent despite different lighting conditions, thus providing less immersiveness towards the users. Some recent AR studies attempted to tune the white balance of the contents aligned to the actual environment[3]. On the other hand, some users may anticipate the memory color, distinctive color of famous anime characters retained by users, regarding the well-known anime characters independently from the context.

However, there does not exist specific ground theory that reflects memory as well as brand color with regards to the natural color rendering strategy. In this circumstance, we investigated anime image adjustments considering illuminant-aware color tuning to anticipate a more satisfied AR watching experiences as well as whether memory color or harmonious color of animatic contents contributes more to a satisfied rendered image. The study investigates anime image adjustments when anime contents are rendered in diverse illuminant contexts. As shown in figure 2 in below, the study accounts for the gap between memory color and the actual color rendering as some users may prefer and expect the memory color of well-known anime characters to appear independent of the context.

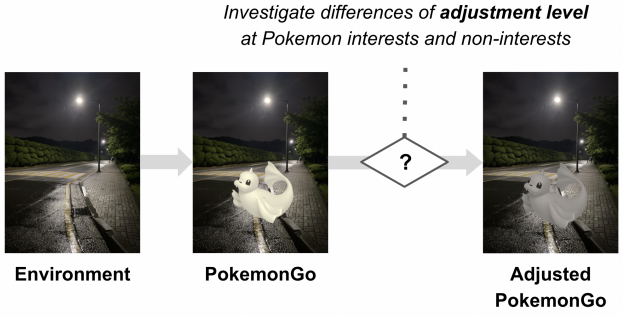

Figure 2. *Overview of the research. This research aims to figure out the color adjustments of the AR anime contents concerning the background illuminant conditions by comparing adjustment level at Pokemon interests and non-interests.*

Figure 3. *Images and color values of 40 environment stimuli used in experiment. Daily images were taken by iPhone 11 allowed auto white balance algorithm (No.1 - No.36), and four additional chromatic environments were added gathered from google image (No.37 - No.40). All the color values were measured by color meter (CS-200, Konica Minolta)*

Methods

The methods for the experiment are established as follows: 1) Stimuli design 2) Design workshop. For the stimuli design, 40 context images were collected from various illuminant conditions. Subsequently, we carried out a design workshop and recruited six designers to adjust Pokemon images.

Stimuli Design

Environment

A total of 40 contexts were collected under various illuminant conditions. Among the 40 environmental stimuli, 36 of them were collected manually using the iPhone 11 (No.1 - No.36). For each of the collected images we allowed the iPhone's auto white balance (AWB) to reflect users' actual environment. Color meter (CS-200, Konica Minolta) was used to measure the illuminant of the environment in CIE xyY 1931. Four additional context images are added for considering chromatic lighting stimuli (No.37 - No.40). Environment images and color values are shown in Figure 3.

Pokemon

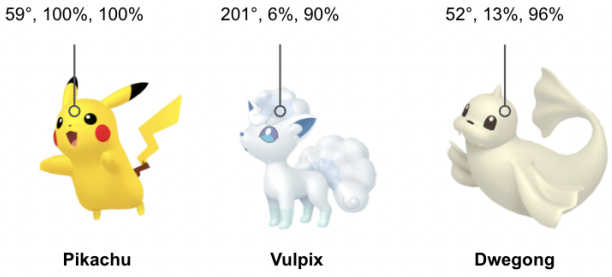

Figure 4. *Three Pokemons used in experiment. (Left) Pikachu, the most representative Pokemon with yellow color, (Middle) Vlupix, Pokemon with cool white skin, (Right) Dwegong, Pokemon with neutral white skin. The circle shows representative points in Hue, Saturation, and Lightness of each Pokemon.*

Three kinds of Pokemon characters were selected for the de-

sign workshop as shown in Figure 4. 1) Pikachu, the most representative Pokemon, has a distinctive memory color of yellow as being one of the most famous anime characters. The choice of the two other Pokemons were selected to consider our wild environmental stimuli that covers chromatic lighting in various illuminant conditions. Hence, Pokemon with a warm white and cool white color were purposely chosen for this workshop: 2) Vulpix, Pokemon with cool white skin, and 3) Dewgong, Pokemon with neutral white skin were selected for this investigation.

Design Workshop

We recruited six design students who were fluent in using Adobe Photoshop 2021. Among six participants, three were highly interested in Pokemon, while the others were only knowledgeable. After the workshop, each designer was rewarded with 20$.

Participants were instructed to adjust the color nuance of 120 (40 background stimuli $\times$ 3 pokemons) images to match with the 40 backgrounds using the 16-inch Macbook Pro display. With an approximate experimental duration of two hours, we limited the adjustment features to the hue, saturation, and lightness controls provided by Adobe Photoshop. Likewise, the participants were asked to modify the HSL slider of three pokemons on separate layers to make their color adjustments. The full procedure is illustrated in Figure 5.

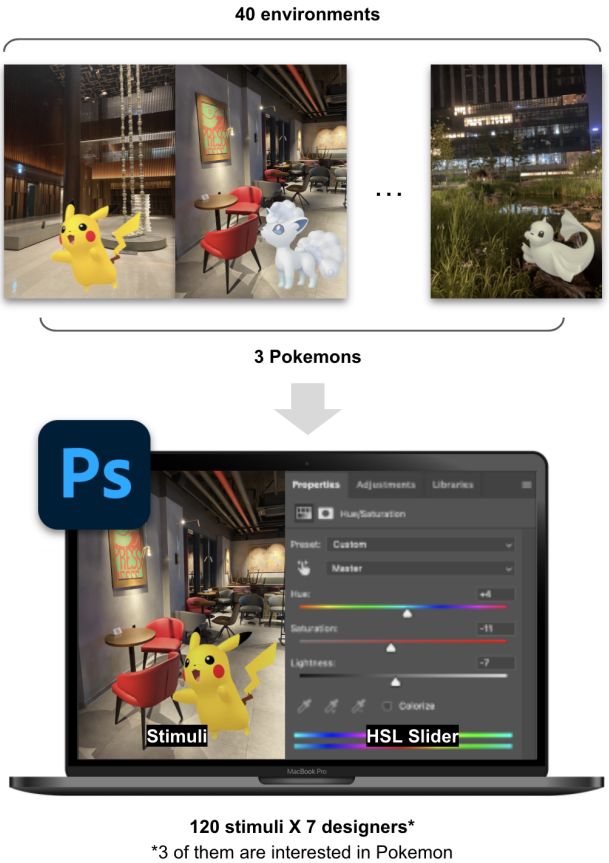

Figure 5. *A total of 120 stimuli of the experiment, and the character color was adjusted to achieve a naturally embedded look.*

Results

We received a total of 840 images adjusted by seven participants. We quantify the image characteristics in terms of hue, saturation, and lightness. Firstly, regarding the context images, we performed the Gray-World algorithm, illumgray(), in Matlab 2021a that resulted in the illuminant information in RGB values. We converted them into HSL to straightforwardly respond to hue, saturation, and lightness properties. Secondly, we picked a color from the representative region of the Pokemon characters in the HSL color system. We collected the colors from adjusted Pokemon images.

Based on the HSL attributes, we examined the correlation between the context characteristics and the changes of adjusted images. As H value composed of angular value, so we calculated angular correlation for H value. The following Table shows the correlation coefficients of H (Table 1), S (Table 2), and L (Table 3) values between context images and adjustments of Pokemon characters. Overall, we found positive correlations. The tendency is stronger when the characters are achromatic (Vulpix, Dewgong), and the participants had little interest in pokemon. Concerning the HSL attributes, saturation showed the most noticeable change, followed by lightness and hue.

Table 1: Angular correlation coefficients between context images and Pokemon character adjustments in terms of Hue. The results are divided by their personal attachments. An asterisk indicated significance at $p < 0.05$

Hue	Pikachu	Vulpix	Dewgong
Pokemon fans (N=3)	0.103	0.215	0.428*
Regular users (N=3)	0.259	0.385*	0.789*

Table 2: Correlation coefficients between context images and Pokemon character adjustments in terms of Saturation. The results are divided by their personal attachments. An asterisk indicated significance at $p < 0.05$

Saturation	Pikachu	Vulpix	Dewgong
Pokemon fans (N=3)	0.216	0.620*	0.598*
Regular users (N=3)	0.308*	0.635*	0.837*

Table 3: Correlation coefficients between context images and Pokemon character adjustments in terms of Lightness. The results are divided by their personal attachments. An asterisk indicated significance at $p < 0.05$

Lightness	Pikachu	Vulpix	Dewgong
Pokemon fans (N=3)	0.244	0.591*	0.298
Regular users (N=3)	0.566*	0.616*	0.547*

Discussion

In this study, we tried to observe the color adjustment level of AR anime contents by conducting design workshops from users. We observed the difference by conducting experiments between

three pokemon fans and three regular users. High chromatic and representative pokemon, such as Pikachu, changed less. However, designers changed achromatic pokemon more than Pikachu, especially controlling their saturation. Compared to regular users who change the pokemon color significantly correlated to the environment, fans controlled the pokemon colors relatively less.

Pokemon fans less adjusted color of Pokémon, and both fans and regular designers tune color smaller of the representative Pokemon, Pikachu. The research showed a similar result with Marino et al.'s research that the color of the anime content is not required to match with the environment [3]. According to the results, we investigated that the memorial color should be rendered rather than matching to the environment if contents had clear memorial color.

Among the results, saturation strongly correlates with the viewing environment in both user groups. The result implies that adjusting the saturation according to the environment should be required while creators create AR content. In addition, the general user also showed a correlation in lightness. It confirmed that creators should consider color rendering based on their target fans or general users when developing AR content. The illustrative example was shown in Figure 6.

Figure 6. *The general tendency follows the context image characteristics, while personal attachment to the Pokemon detained the adjustments.*

Conclusion

This study observed how the colors of AR anime renderings are adjusted depending on the context. Differently from previous studies, we were open to admit color memory in the context of AR contents while still assuming the color tuning aligned to the context. Based on the workshop results converted into HSL attributes, we figured out the general tendency correlated with the context images, but the hue adjustments were the last concern. Moreover, we discovered that Pokemon fans were less likely to adjust the colors. We consider there is a trade-off between natural rendering and color memory when users make the judgment of the image quality of AR contents.

Acknowledgments

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Author Biography

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