Investigation of Kansei Added Value in Book Publishing Filed by Using AR Contents

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Abstract: Many practices about using AR (augmented reality) contents have been reported in education fields, and the usefulness of teaching materials made by AR technology was verified. However, the study cases about using AR contents for book publishing are still scarce. With the publication of eBook, the possibility of AR contents increases and the synergistic effect could be expected. This study introduced the AR contents into book publishing field, gives three-dimensional depth to the visual information of two-dimensional original that in order to create multimedia "pleasure". We targeted parent and child as our custom, and developed character AR contents to the picture-book. Readers can acquire the 3D data and of characters and compounds on the picture-book by using iPhone or iPad. We made comparative experiments by using manufactured AR contents. As the results, there was a tendency that the story in picture-book forms and with AR contents increased the understanding than the story written only in the text. Moreover, by adding AR contents to the 2D picture-book form, "pleasure", "fun" and "unpredictability" can be improved.

Keywords: AR contents, Book Publishing, Application, 3D contents.

1. INTRODUCTION

Augmented reality (AR) technologies have been in focus recently, and their application in real-world society is increasing. Moreover, with the spread of smartphones and tablet PCs, more applications of AR technologies to the content market are expected. There are several reports of research in AR in the field of education. Teshima, Kosugi et al. (2009) developed teaching aids for learning about maps using AR and demonstrated their effectiveness compared to methods that only use photographs or printed materials. They showed that displaying a virtual object juxtaposed over a printed page effectively promoted learning. In another example, Kondo et al. (2006) developed an AR teaching aid that uses computer graphics to show the structure of the brain in 3D.

Nevertheless, there have been few examples of research related to AR for books in general, and there is considerable room for discussion. Further, there is a need to evaluate AR content considering the cases where AR is linked with a tablet PC.

In this research, we developed an AR app for books in cooperation with a general publishing company, searched for new methods to use AR with mobile devices, and examined the effectiveness and market value of introducing an AR app for books.

2. AR APP DEVELOPMENT

For this research, we used Xcode by Apple, Inc., as an integrated development environment (IDE), and used Objective-C as the programming language. For a system development kit (SDK), we used Metaio SDK by Metaio, GmbH, and created an app exclusively for iOS devices.

For the content, we cooperated with a general publishing company to use a title called Genshoku Yagai Yousei Zukan (“Color Field Guide to Fairies”), which is being developed on the publishing company’s web site and as a magazine. We created an AR app for tablet PCs that juxtaposes three-dimensional computer graphics (3DCG) images of fairy characters over printed paper.

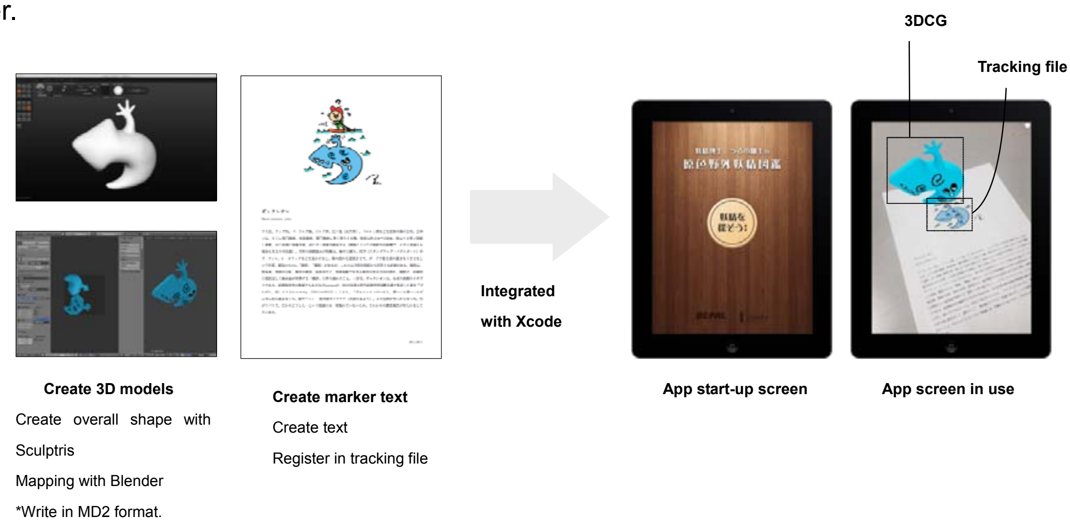

Figure 1: Overview of experimental AR content used in this

Figure 1 shows an overview of the experimental AR app used for this research. By directing a camera linked to the AR app at a text passage including markers for character illustrations, users can view 3DCG models of fairy characters juxtaposed over the marked text. Moreover, because the 3DCG models move in coordination with the orientation of the text, users can freely move the text to view the character from multiple perspectives.

2.1. 3D Model

To show the effectiveness of AR content over printed media, we created two 3DCG models using the Sculptris and Blender 3D-modeling software programs. We created 3DCG models with less than 20,000 faces, which the AR app could read. Then, we used Blender to adjust the size, apply texture, and perform shadow mapping. We wrote the models in the MD2 format, which can be read as AR content.

2.2. AR App

In the AR app system, first, the app recognizes an image marker printed on paper. Next, the app processes the position information of the marker and displays a 3DCG model juxtaposed over the printed page.

To make the AR app display the 3DCG models produced, we used Xcode to read the 3DCG models into the AR app. To facilitate the display of multiple characters within the app, we applied an ID to the loaded 3DCG models to allow specifying multiple fairy characters. Moreover, to use fairy character illustrations as image markers, we registered them as tracking files. To allow the tracking files to handle multiple displays, we used the same ID as that for the corresponding 3DCG model. In this manner, a corresponding 3DCG model could be displayed juxtaposed over any image marker. Furthermore, the startup screen was created such that it could handle both vertical and horizontal orientation to allow users to hold the device in any position as they operate the app.

3. EVALUATION EXPERIMENT

3.1. Experiment Overview

To demonstrate the relative effectiveness of printed-paper content and content using the AR app, we conducted an evaluation experiment. The experiment was conducted twice for each subject. The AR app was evaluated by 32 subjects between the age group of 10–20 years using a questionnaire. Moreover, to investigate the effect on the brain waves of the subjects using the AR app, we used the simple brainwave measurement device, MindSet, manufactured by NeuroSky, Inc., during the test. In the experiment, MindSet was embodied as a headphone, with the left ear pad functioning as the ground electrode, and the arm section electrode measuring the voltage at a position corresponding to FP1. The measured brainwaves are immediately amplified, and the environmental noise and effects of muscle movements are eliminated before being outputted in 8 bandwidths, such as α and β waves, by performing a Fourier transformation. Finally, all subjects were required to sign an agreement that they would treat the experiment content as confidential information in accordance with a confidentiality obligation in joint academic and industry research.

3.2. Experiment Method

For the experiment environment, a room with a light gray color scheme and daylight fluorescent lamps was used to avoid sensory stress on the subjects. The desks used for the experiment only had the content to be used in each test placed on them. To ensure that the electrodes would operate normally on the subjects, they were wiped using alcohol before the experiment. The subjects' hair was tied back with hairpins to ensure that it would not entangle in the electrodes. Next, MindSet was mounted as per the instructions in the operation manual. The subjects were asked to adjust the position of the pads and the arm to fit the device to their heads.

The text was presented face down so that the content was not visible. To ensure that the subjects were in a relaxed condition, they were required to close their eyes. Brainwave measurement commenced when a meditation (level of meditation) meter and an attention (level of concentration) meter had stabilized. Five seconds after this stage, on a signal, the subjects turned the text over and viewed it for one minute. Then, they were asked to fill in an evaluation sheet, and after taking a break for as long as they preferred, the next experiment was performed.

Each subject made an evaluation of the two characters, structured in three steps. Experiment 1: A written response describing the character (the "description text"); Experiment 2: A written response with an illustration of the character (the "illustration text"); and Experiment 3: A written response with an illustration of the character and the AR app (the "AR text"). The subjects were made to view each character for 1 min and then respond in five steps using the evaluation sheet. The evaluation sheet comprised 15 evaluation statements in total, covering "desire" (four statements), "interest" (two statements), "ease of viewing" (one statement), "self-comprehension" (six statements), and "sense of fatigue" (two statements). The evaluation values ranged between +2 and −2. The results of Experiment 2 were evaluated relative to the results of Experiment 1, and the results of Experiment 3 were evaluated relative to those of Experiment 1 as Experiment 3-1, and those of Experiment 2 as Experiment 3-2.

In the analysis, the results from Experiment 1 were assigned five points for "strongly agree," four points for "somewhat agree," three points for "neither agree nor disagree," two points for "somewhat disagree," and one point for "strongly disagree." The results from Experiment 2 were added to the results of Experiment 1. The results from Experiment 3-1 were added to the results from Experiment 1, and the results from Experiment 3-2 were added to the results from Experiment 2.

Next, Tukey's test was used to perform a multiple comparison of the results for each evaluation statement in order to clarify the significant difference between each experiment.

3.3. Experiment Results

Figure 2 shows the results of the questionnaire used in the experiment. There were 32 valid responses. With respect to the collated results, in Experiment 3-1, description text vs AR text, and Experiment 3-2, illustration text vs. AR text, 11 out of the 15 evaluation statements had an average score above the median score of 3. In particular, with respect to the statements related to "desire" and "interest," the scores from Experiment 3-1, description text vs. AR text and Experiment 3-2, illustration text vs. AR text were higher than the scores from Experiment 2, illustration text. Moreover, with respect to the statements on self-comprehension, "This text was interesting," "From text I could describe the form of the character," and "The character had cute hair," had the highest scores for Experiment 3-2, illustration text vs. AR text. These results demonstrate the effectiveness of introducing the AR app for books.

However, the response scores for the "ease of viewing" statement, "I was not sure where to look," and the "self-comprehension" statement, "The content was serious," were lower in Experiment 3-1, description text vs. AR text compared with Experiment 1, description text, and lower in Experiment 3-2, illustration text vs. AR text compared with Experiment 2, illustration text. Furthermore, the scores for the "self-comprehension" statement, "I read the text actively," were lower in Experiment 3-2, illustration text vs. AR text compared with Experiment 2, illustration text. The reason for these differences is thought to be that the line of vision tends to focus on the AR character when operating the AR app.

We performed a verification using Tukey's test to clarify the effect of the presence of the AR app. In the average response scores relating to "Desire" and "Interest," there was a significant difference ($\alpha(64) = 3.733$, $p < 0.05$). This clearly showed desire for books using the AR app was stimulated by displaying 3D characters juxtaposed over the printed page. It was also made clear that subjects approached books using an AR app with interest.

There was also a significant difference (α (64) = 3.733, $p < 0.05$) in the average response scores for the "Self-comprehension" statements, "This text was easy to get used to," "From the text I could describe the form of the character," and "The character had a cute air." This showed that the subjects' level of self-comprehension was improved by the AR app.

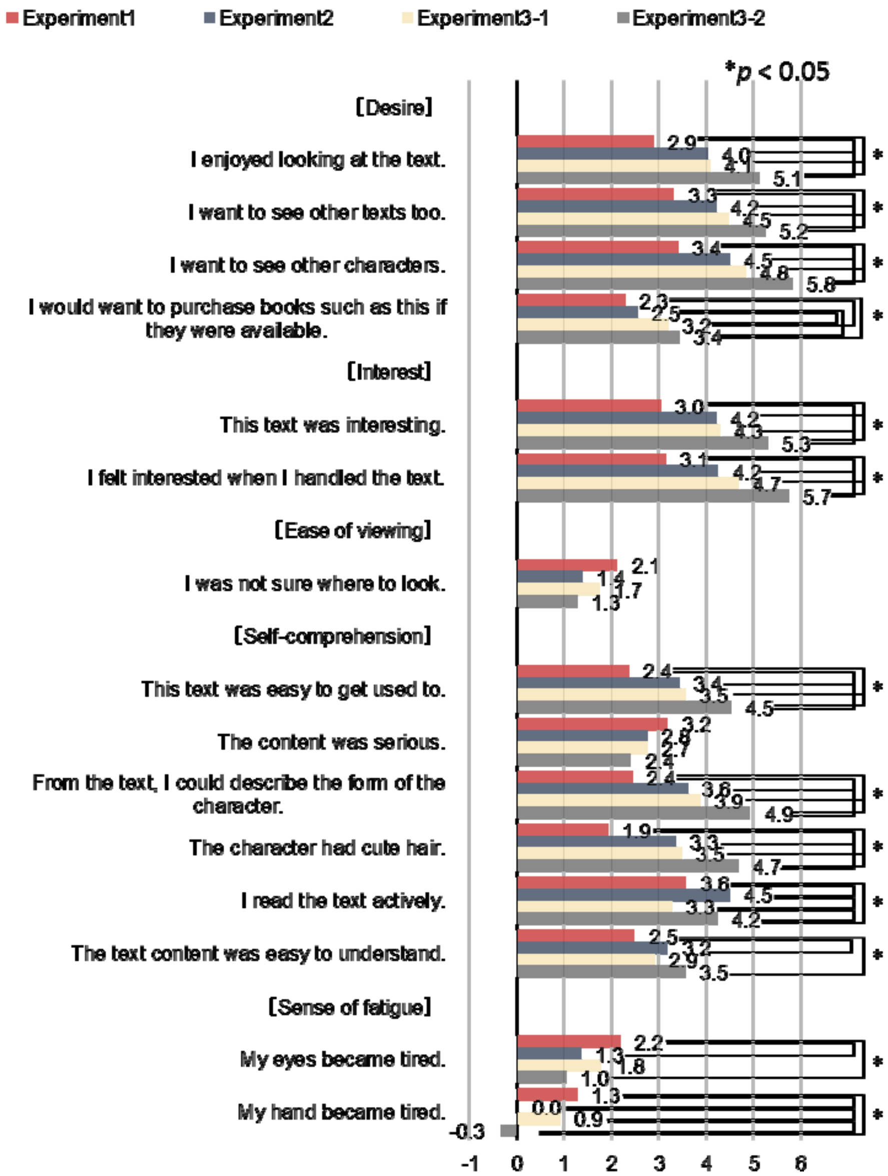

Figure 2: Results of subjective evaluation

Figure 3,4,5 shows the collated results of the brainwave measurements in the experiment. The first five seconds of data was discarded from the data of each experiment. To find the levels of meditation and concentration in each experiment, we calculated the average value of the data for one minute and the total value for the subject. As a result, both the level of meditation and the level of concentration were found to be lower in Experiment 3 than Experiment 1. Because the level of concentration is associated mainly with the ability to focus visually on a single point, this result shows that the subjects were looking back and forth between both the printed paper and the AR app because the viewing content was increased.

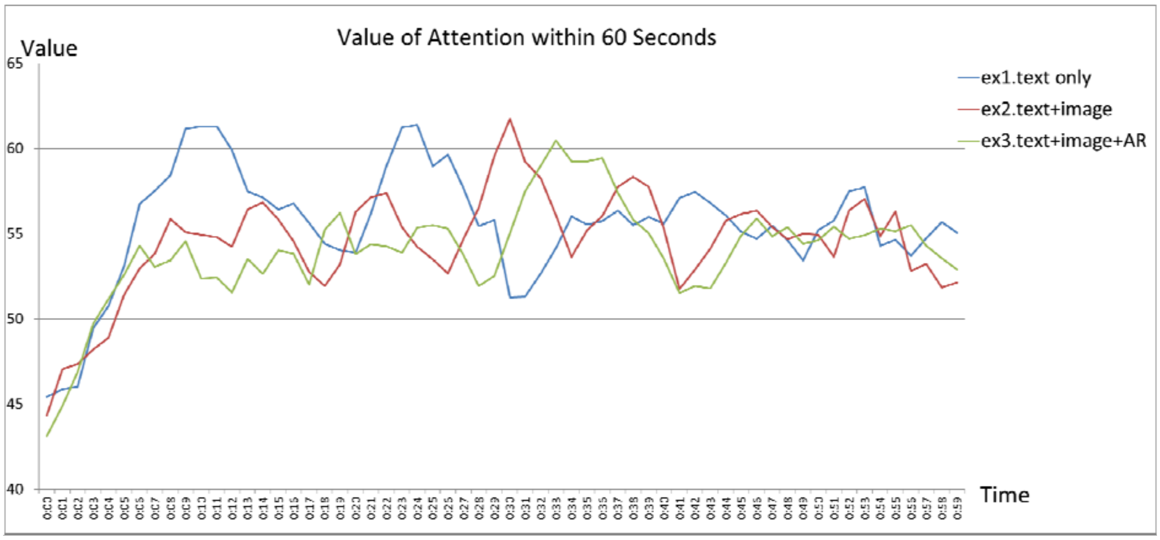

Figure 3: Moving average value of “Attention” within 60 Seconds

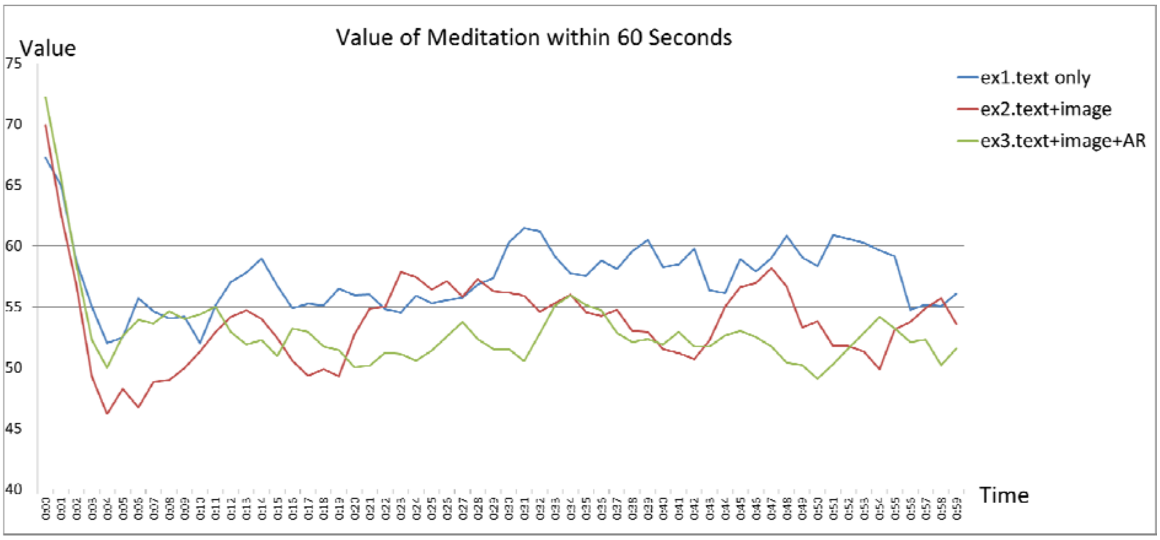

Figure 4: Moving average value of “Meditation” within 60 Seconds

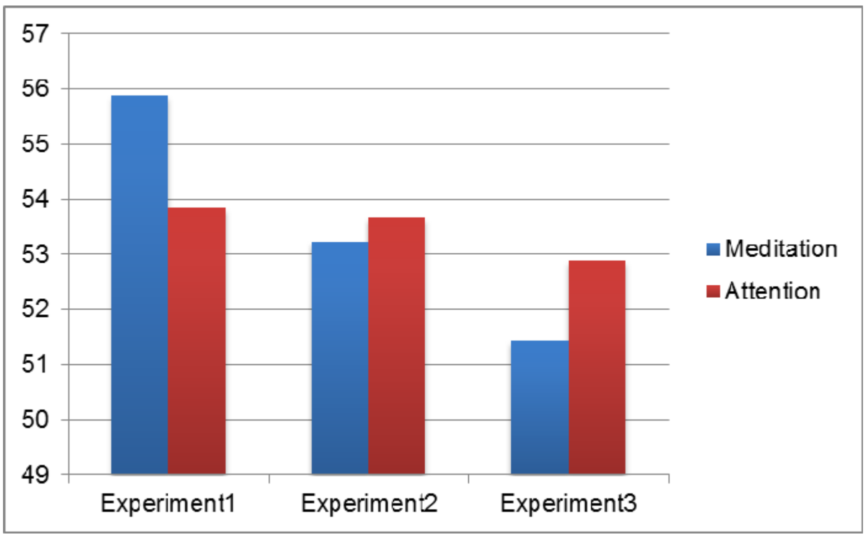

Figure 5: Collated results of brainwave measurements

Furthermore, the level of meditation was higher than the level of concentration in Experiment 1, but the level of concentration was higher than the level of meditation in Experiment 3. From this result it can be seen that introduction of an AR app stimulates brain activity.

4. CONCLUSION

In this research, we cooperated with a general publisher to develop an AR app for books to identify new methods of operating mobile devices and to investigate the effectiveness and market value of introducing an AR app for books. We found that introducing an AR app for books stimulated the users' desire and made them approach their pursuits with interest. Further, we showed how such an introduction could have market value by stimulating the desire to purchase books. Finally, we demonstrated that users looked back and forth between the printed media and the AR app, and therefore, their level of concentration increased above their level of meditation, and their brain activity changed from quiet to excited.

In our future work, we could include improving the 3D characters with the goal of increasing the desire and interest of the subjects. Moreover, this research used a single printed sheet of A4-sized paper to investigate the effectiveness of the AR app; however, actual application for books will require conducting further experiments using text in book form.

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