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Verification about a button solidity in a touch-panel terminal

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Abstract
Many contrivances to give a button image solidity have been used in an interface design in order to enhance convenience for users by evoking operation to associate the real one.
The previous study shows that it is possible to perceive the three dimensional space from the two dimensional image with the luminance change via linear gradation.
As with the spread of touch-panel terminals in recent years, many studies about the interface design for touch-panel terminals have been conducted, however less studies about the brightness value of the linear gradation have been conducted.
We conducted an experiment about the luminance value of the linear gradation in gray scale, focusing on a button solidity in a touch-panel terminal in this study. As a result, strong correlation was observed between the highlight and the shadow of the gradation, the average brightness difference between the two was 63.22% and the true value was between 62.20% and 64.23%.

Keywords: button design, solidity, interface of touch-panel terminal

1 Introduction

(1) Research background

A touch-panel interface has been used mainly for ATM's at financial institutions, car navigation system, exhibition guides at museums, and as it is currently used for cell phones, portable game machines, mobile information terminals it has rapidly spread to our daily life.

Portable devices with a touch-panel interface has not only attracted people who use electronic devices on a daily basis but also people who have not used them before.

Operation of a touch-panel interface does not require an external input device in particular unlike old computers and cell phones. Users operate the touch-panel interface with their fingers while looking at the monitor.

On the other hand, interface design was performed on the assumption that there was an external input device before. As one of the expressions being used often on web sites, it is that images and text decoration change when a cursor comes in contact with images and texts. It is intended for users to distinguish selectable informations from the others. Apart from that, it makes it easier for users to operate a device, it enhances affordance as contrivance, and makes it easier for texts and images with operation to associate intuitively, it is intended to look like a bottom by giving an image solidity. The information previously stated can be considered as intentional. Each is an important factor in designing interface, especially for a touch-panel terminal that users only get an indication from the monitor that suggests it needs to be further consideration. In this research of an interface design in a touch-panel terminal, button solidity is also especially considered.

(2) Previous research

1. Perception of depth by the luminance change

Three dimensional space is perceived from two dimensional images based on various assisting factors about depth on a daily basis. One of the assisting factors about depth is shading thar we perceive as depth by the presuming location of the light source based on luminance change. Kleffner and Ramachandran (1992) conducted the experiment of adding a luminance change to inside of a circle by linear gradation and confirmed these two conditions "constraints of the light source above *2" and "Constraints of single light source *3".[1][2] Human perceive shaded linear gradations as convex or concave, specially with a top bright as convex and vice versa. (Figure 1)

Granrud , Yonas and Opland (1985) have done a research through the use of characteristics of infants reaching curved objects in their development. That research suggests that 7-month-old infants can perceive three-dimensional space from shading.

In most experiments how humans perceive three dimensional space from shaded two dimensional images was focused and researched. On the other hand, there is not much research about shading itself nor a specific description about brightness. However solidity should differ by brightness of shading.

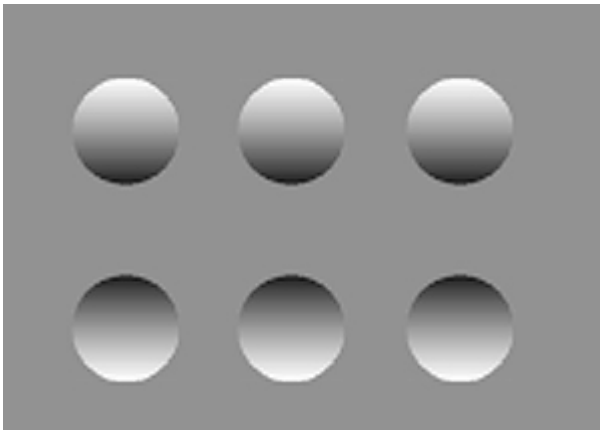

Figure 1:

A sample display adding a luminance change to the inside of a circle by linear gradation

(3) Research purpose

In interface design for touch-panel terminals, it is expected that a bottom solidity enhances affordance and makes it more user-friendly. For example, studies of the effects of button size and study of the effects of color on the screen have been made.[3][4] In addition, most of the researches about operability of touch-panel terminals use a convex bottom but there is not much research about how a bottom solidity is provided.

This purpose of this research is to examine if there is optimal value of luminance of linear gradations given to the bottom image. We first examined the correlation between the bottom image and luminance difference of linear gradation in the gray scale.

2 Experiments

Participants made images where they can perceive them as bottom mostly by changing the luminance value. We analyzed the results. We also conducted preliminary experiments so that participants can get used to this operation.

(1) Materials

An application was created for both this experiment and the preliminary experiment and then the experiment was conducted on a touch-panel terminal (iPad mini). The experiments were carried out in a bright room with a fluorescent lamp during the day. Brightness setting of the display that was used in the experiment is the same.

A bottom image is in the gray scale, 100px×100px, radius 10px rounded rectangle.

A slider is used to adjust the linear gradation luminance, luminance is adjusted by operating the slider horizontally.

24 people both male and female in 20's participated in the experiment.

The top of linear gradation is now called high light and the bottom shadow is called in order to create convenience. (Figure 2)

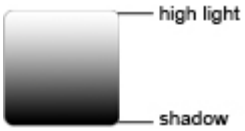

Figure 2: high light and shadow

(2) Procedure

1. Preliminary experiment

We explained to participants by speaking that we wanted them to adjust the luminance value with the slider where they feel the bottom image located in the center looks like a bottom and participants performed at their own pace.

Figure 3 shows the experiment screen. One bottom image that they adjust is located in the top center of the screen and the slider for adjusting luminance value is located in the bottom center of the screen. When participants finish adjusting luminance value they then touch the bottom image to determine the value.

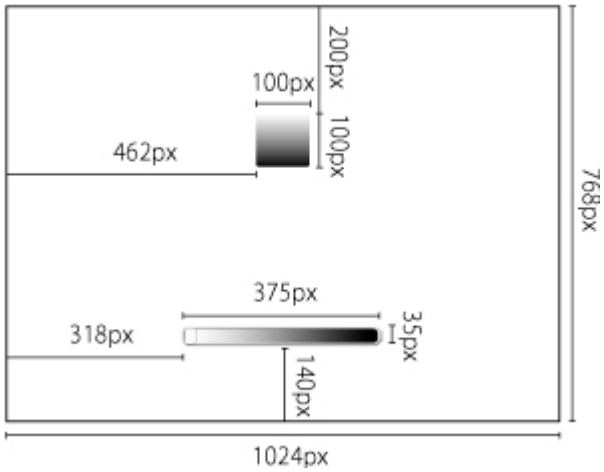

Figure 3: Preliminary experiment screen

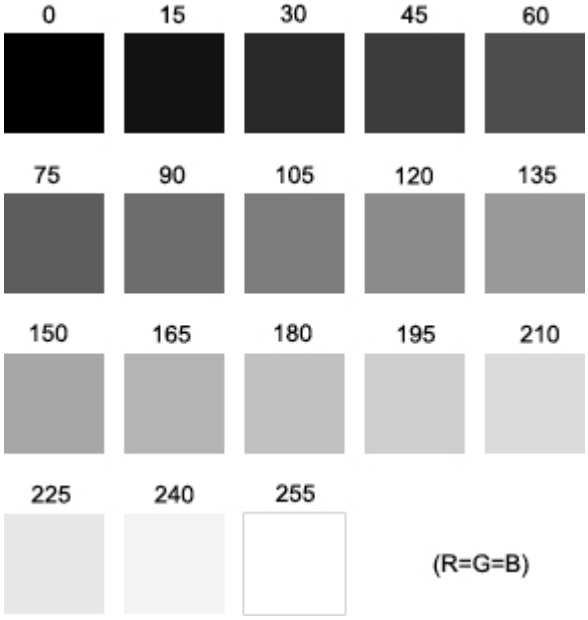

Figure 4: Preliminary experiment screen

This experiment is conducted in order for participants to get used to operation and seeing various gradation patterns as follows:

ⅰ. Shadow value is locked as (0,0,0), highlight luminance value is adjusted.

ⅱ. Shadow value is locked as (15,15,15), highlight luminance value is adjusted.

ⅲ. Process ⅰ～ⅱ is repeated till shadow value reaches (255,255,255).(Figure 4)

ⅳ. Highlight value is locked as (255,255,255), shadow luminance value is adjusted.

ⅴ. Highlight value is locked as (240,240,240), shadow luminance value is adjusted.

ⅵ. Process ⅳ～ⅴ is repeated till shadow value reaches (0,0,0).

Locked value changes at regular intervals.

2. The actual experiment

As with the preliminary experiment we explained to participants by speaking that we wanted them to adjust luminance value with the slider where they feel the bottom image located in the center looks like a bottom and participants performed at their own pace.

Figure 5 shows the experiment screen. One bottom image that they adjust is located in the top center of the screen, the slider for adjusting highlight luminance value in the bottom left of the screen and the slider for adjusting shadow luminance value in the bottom right of the screen. When participants finish adjusting luminance value they then touch the bottom image to determine the value as well as the preliminary experiment.

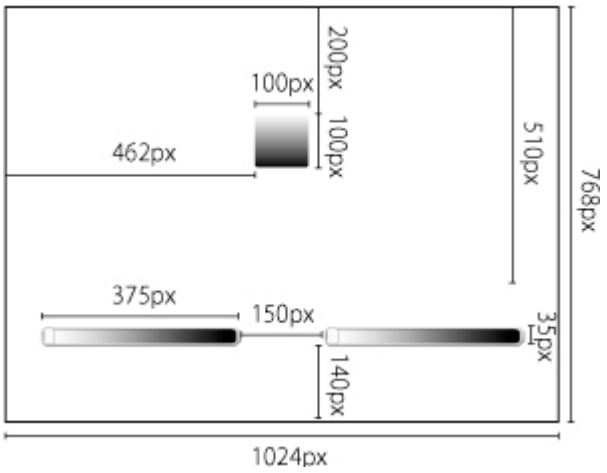

Figure 5: The experiment screen

In the experiment, from the top left of the screen, in range 1024px×510px background color is applied. The relation between highlight/shadow value in linear gradation and background color value was examined.

This experiment is conducted as follows:

Ⅰ. Background color is locked as (255,255,255), luminance value of highlight and shadow is adjusted.

Ⅱ. Background color is locked as (240,240,240), luminance value of highlight and shadow is adjusted.

Ⅲ. Process Ⅰ～Ⅱ is repeated till background color reaches (0,0,0).

Ⅳ. Process Ⅰ～Ⅱ is repeated till background color reaches (255,255,255) back again.

Locked value changes at regular intervals. The white screen is presented for 3 seconds at intervals between each of the trials.

3 Result and discussion

RGB data obtained in the experiment was HSV converted and the brightness was examined.

Brightness (%) was calculated by the following formula;

$$V=\{(\text{Maximum RGB})/255\}\times 100$$

In addition, numerical value that rounded off to the 3rd decimal point is described henceforth.

(1) Correlation between background color and value of highlight and shadow

In between background color and highlight, between background color and shadow, mean value was calculated and correlation coefficient was calculated.

A correlation between background color and highlight was -0.38. A correlation between background color and shadow was -0.56. As the result of the verification, there was no correlation seen in the previous information.

While both highlight and shadow tend to get darker as background color gets brighter on scatter diagram 6 and 7, there was no specific relevance between background color and the value of highlight and shadow.

Also the difference between the value of highlight and shadow was calculated, and calculated correlation between the difference and background color was -0.11, therefore, there was no correlation seen in those. From this it is considerable

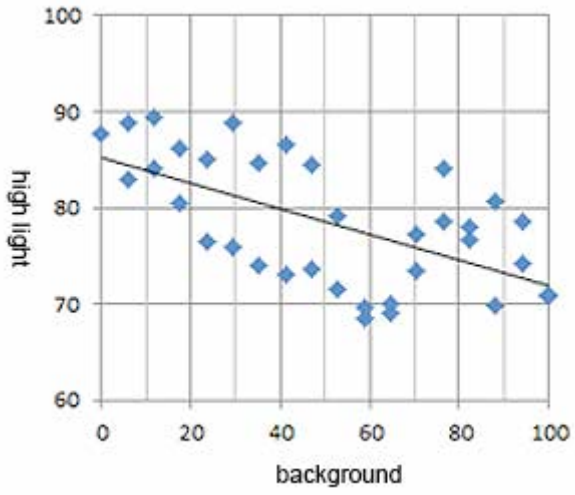

Figure 6: scatter diagram (background color - highlight)

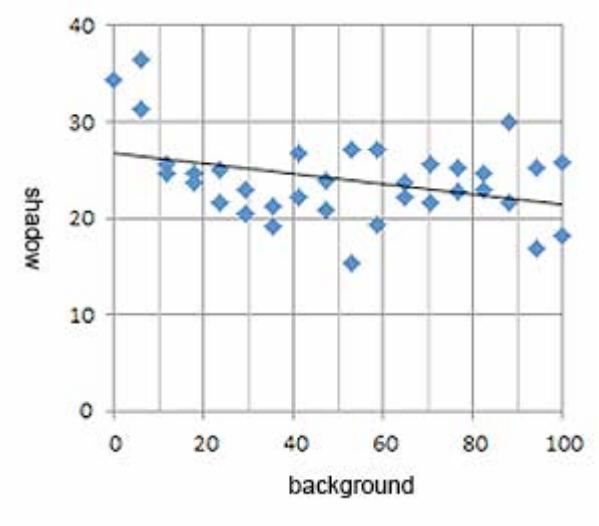

Figure 7: scatter diagram (background color - shadow)

that the difference between the values of highlight and shadow is almost the same regardless of the brightness of background color.

(2) A correlation between the values of highlight and shadow

A correlation between highlight and shadow was 0.57 and there was a weak correlation between those two as the result of verification.

Figure 8 is the created scatter diagram.

Looking at the data in detail, some data of concave in bottom images were seen. Concave bottom image has lower value of highlight than shadow and the previous study shows linear gradation like that which is perceived as concave. We excluded the concave bottom image data from the data and re-examined the correlation. Correlation coefficient between the two was 0.88 and it became a stronger correlation. Figure 9 shows the scatter diagram. From the result, there is probably correlation between highlight and shadow, however it is considerable that convex bottom is not always preferred.

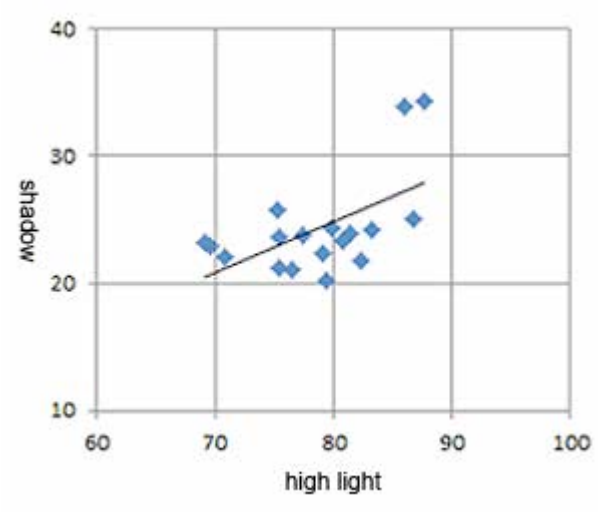

Figure 8: Scatter diagram

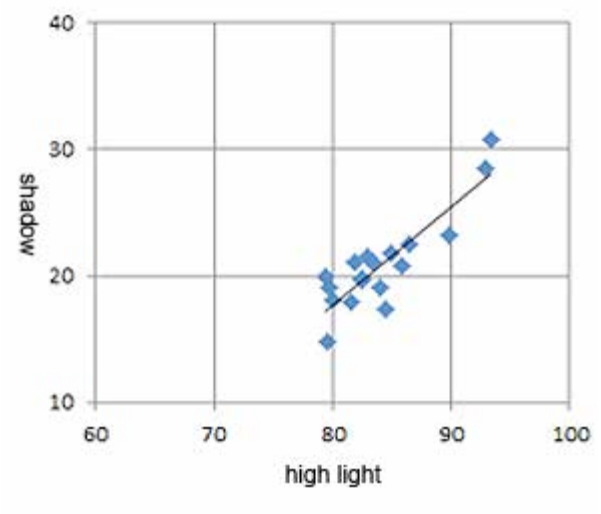

Figure 9: Scatter diagram
(in the case of excluding concave bottom)

(3) Discussion about concave bottom

There were 10 participants who created several concave bottoms out of 24 participants. The breakdown of that is as follows; 2 participants created 2 concave bottoms, 2 participants created 9 concave bottoms, 2 participants created 10concave bottoms, 1 participant created 1 concave bottom, 1 participant created 3 concave bottoms, 1 participant created 7concave bottoms, and 1 participant created 20 concave bottoms.(Figure 10)

concave bottom image data	0	1	2	3	7	9	10	20
participants	14	1	2	1	1	2	2	1

Figure 10: participants who created several concave bottoms

In the Kleffner and Ramachandran (1992) experiment, it is reported that detecting concave bottom out of convex bottom group (Figure 12) is more sufficient than detecting convex bottom out of concave bottom group (Figure 11). *4

In this research, it was observed that 11 participants created concave bottoms at different times. In the Kleffner and Ramachandran experiment, as grouping of convex bottoms is stronger than grouping of concave bottoms, it is possible that it made it easier to find concave bottoms in a convex bottom group. With only their experiment it remains unclear that concave bottoms have more visibility compared to convex bottoms and it still remains unclear which one has preference, the convex or concave bottom in this experiment. However more than half of the participants did not create concave bottoms and there were a few concave bottoms out of all the trials. From these reasons convex bottom has more preference in bottom design.

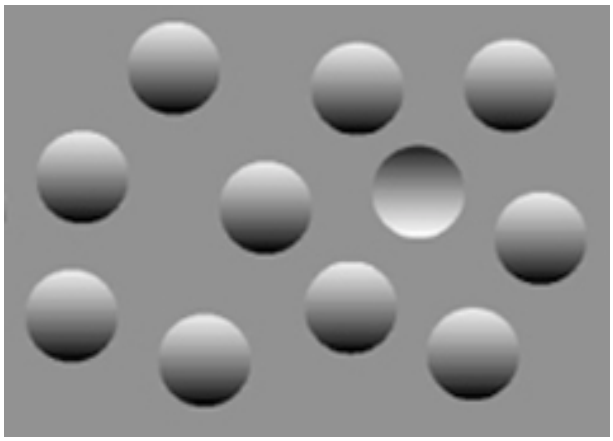

Figure 11 :
Detecting concave bottoms out of convex bottom group

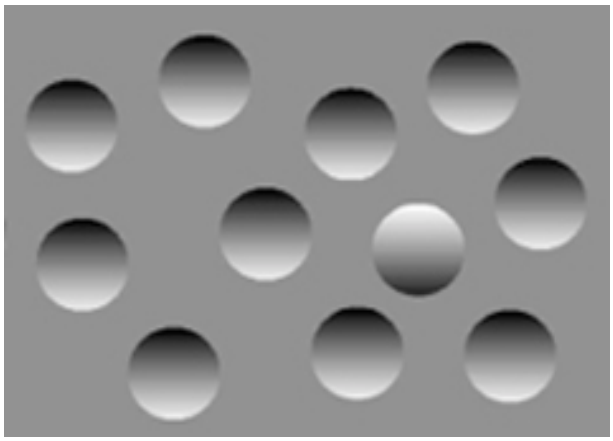

Figure 12:
Detecting convex bottoms out of concave bottom group

(4) Estimation of brightness difference

Based on data obtained we calculated the mean value of brightness difference between highlight and shadow and the result was 63.22%. μ is estimated for the 95% confidence interval and it was 62.20 <μ<64.23. (Figure 13)

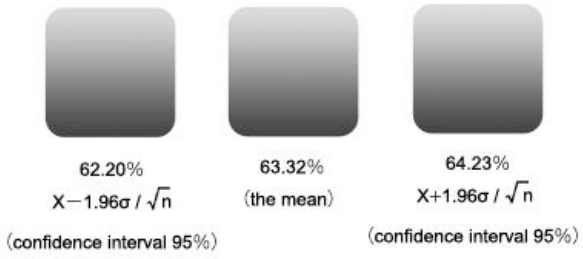

Figure 13: Results

4 Conclusion

In this research we conducted experiments with the purpose of examining if there was optimal value of brightness of linear gradations given to the bottom image. For the experiments we created an application where the brightness of linear gradation is adjusted respectively and we used the application.

The results of the experiments shows that while between the background color of gray scaled bottom and the value of highlight/shadow, highlight/shadow both tend to get darker as the background color gets brighter, there was no correlation between the two.

On the other hand, there was a strong correlation between the values of highlight and shadow and the brightness difference was 62.20 <μ<64.23. However as for the brightness difference in spite of no presentation to exclude concave bottoms in advance concave bottoms were excluded from the experiment result. That might have affected this experiment result and it is possible that the true value could be different from the the result of this experiment. To assess reference of convex/concave in bottom image still requires another experiment.

In the actual bottom design, even in gray scale there are bottoms that are whiter, or that are blacker, that are in between to be considered as various patterns. Optimal value of brightness difference in each case is a future problem and we will continue to conduct experiments about the influence of color being given.

References

[1] Dorothy A. Kleffner , V. S. Ramachandran, *On the perception of shape from shading*, Perception & Psychophysics, Vol. 52, pp. 18-36, 1992.

[2] Inoue Hiroyoshi, *The effect of highlight and shadow on the circle depth perception: depth perception and behavior*, Kumamoto University Academic Repository, 2008.

[3] Nishimura Takahiro, Seo Akihiko, Doi Kouki, *Influence of Size and Shape of Switch on Operability in Portable Resistive Touch-Sensitive Screen*, Transactions of the Japan Society of Mechanical Engineers, Series (C), Vol.(77), No(780), 2011.

[4] Sakamoto Makiba, Sato Hidetsugu, *Relationship between Color Design of a Touch Panel Interface and Its Usability*, Japan Society of Kansei Engineering Journal, Vol.(10), No(4), pp. 543-550, 2011.

Annotation

*1 Affordance

Mainly the term affordance is used as Norman's theory states, in this paper "an action possibility which allows an individual to perform an action". Though in recent years Norman's affordance is called signifier in order to prevent misuse of the term affordance coined by Gibson, Gibson's theory states "relevancy between human and object" which is inclusive.

*2 Constraints of the light source above

Humans perceive three dimensional space from shading of two dimensional images by the assumption that the light

comes from above because humans always have the light source from above in the environment.

*3 Constraints of single light source
As for the linear gradation diagram with luminance change symmetrically in the vertical (Figure 1), when one is perceived as convex, then the other is perceived as concave. It's constant unless it's inverted. That shows that there is only one light source from above in addition to constraints of the light source above.

*4 Grouping
A major aspect of Gestalt psychology, "how objects in a visual field are grouped to form one", especially the law of similarity states that elements within an assortment of objects are perceptually grouped together if they are similar to each other. In this paper we use the word grouping as it is.