Proposal for an Affective Skateboard Using Various Lighting Patterns

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Abstract. In recent years, ideas for more enjoyable playing through the use of emotional design concepts like affectivity and pleasurability factors are attracting attention. In this study, we focused on the effect of blinking and moving light patterns on users' enjoyment of skateboards. An evaluation experiment was conducted to clarify users' impressions of these light patterns using the following five evaluation items: (1) level of feeling of wanting to move your body, (2) level of feeling of wanting to get closer, (3) level of feeling of being in danger, (4) level of perception of beauty, and (5) level of preference. From the experiment, we found that there are some characteristics in impression of patterns of blinking and moving light and there is a common impression of the lighting pattern in 'level of feeling of wanting to move your body' and 'level of feeling of being in danger'. Moreover, it was clarified that there are some light patterns that users preferred and felt were more beautiful than others.

Based on these results, a glowing skateboard, named "Glowboard", was proposed using an Arduino system and a non-contact rotation speed sensor. "Glowboard" shows various blinking and moving patterns with different colors of light depending on the rotation speed of the skateboard's tire. From an evaluation experiment with "Glowboard", we found that using the various lighting patterns is effective not only developing performance through riding, but also for evaluating skaters' skill in skateboarding competition. The result is illustrates that "Glowboard" is effective for increasing users' enjoyment. In the future, it is necessary to clarify the impression and influences of different colors of lighting on enjoyment. "Glowboard" will be developed using a wider variety of light patterns based on the results of further study.

Keywords: Affective · Lighting pattern · Skateboard · *Kansei* engineering

1 Introduction

In recent years, the number of products and services to counter a lack of exercise have been increasing. In particular, there is a growing need for users to relieve mental stress and enjoy exercise more. In other words, ideas for more enjoyable play using emotional design concepts that address affective and pleasure factors are attracting attention.

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With this background, some interaction design focuses on the interaction between body movement and light. Good examples include "Orphe (Fig. 1 [1])" and "PRAMA (Fig. 2 [2])." Orphe demonstrates shoes with a lighting function. This idea caters to dancers who want to make their dance more powerful and dynamic by adding light. PRAMA is an example of promoting exercise through the use of light at a sports gym. The concept of these designs is based on the idea of using light to increase motivation to move the body.

Fig. 1. Orphe

Fig. 2. PRAMA

Many services and products such as Orphe and PRAMA have been deployed based on this concept, but currently its application has not clarified the relationship between light and human feeling. It has been established that more effective results can be obtained in the future by using objective research results to develop services and products that use light. However, in many of the approaches, the prototypes incorporate light without consideration for a logical process, such as which element in the lighting pattern makes the strongest impression on users.

In recent years, there have been numerous studies on improving motivation through entertainment. According to Scott et al., there are two factors in entertainment that contribute to motivation, “Group Competition” and “Solo Competition” [3]. Akiyama et al. investigated the relationship between optical property parameters such as “contrast,” “gloss” and “surface gloss” of flooring materials and their visual impressions [4].

In this study, we focused on the effect of blinking and moving light patterns on users’ enjoyment of skateboards. The purpose of this research was to clarify the relationship between lighting patterns and users’ feelings, and to propose an interactive skateboard with changing light patterns based on the rotation speed of the skateboard tire, following experiment results.

2 Evaluation Experiment: The Relationship Between Lighting Patterns and Users’ Feelings

2.1 Purpose and Method of the Evaluation Experiments

Visual inductive self-motion perception (vection) [5] is an approach that involves observing self-body motion, which occurs in the direction opposite to a visual pattern where the regular movement of a large visual pattern occupies most of the field of vision. In this research, the glowing skateboard in the final proposal involves a user who is not only a skateboarder but also the viewer of the skateboarder as a subject, an experience that is judged to be different from the evaluation experiment of the skater affected by ‘vection.’ In this research, an evaluation experiment was conducted to visualize the impression made by various light patterns and to clarify the relationship of the different light patterns to the motivation to move the body.

In the evaluation experiment, each participant saw six types of light pattern. Figure 2 shows the six types of light pattern. These six types of light pattern were created with LED serial tape and the Arduino UNO system, which made it easy to control the lighting and movement of the patterns.

The evaluation experiment was divided into the following two groups: six patterns of light with the condition of moving in a horizontal direction. The experiment was conducted with 38 students of Future University Hakodate on July 7, 2016.

In the experiment involving six patterns of light with the condition of moving in a horizontal direction, the following occurred: (1) For condition A, the lights emerge from the left side and move toward the right (A pattern). (2) For condition B, the lights emerge from the right side, and move toward the left (B pattern). (3) For condition C, both lights emerge from the center, and each light group moves to the left and right (C pattern). (4) For condition D, both lights emerge from the left and right sides simultaneously and move into the center (D pattern). (5) For condition E, the lights emerge from the left side, and move toward the right in an irregular pattern that goes back and forth (E pattern). (6) For the last condition F, the lights emerge from the right side, and move toward the left in an irregular pattern that goes back and forth (F pattern).

Figure 3 shows the six lighting patterns.

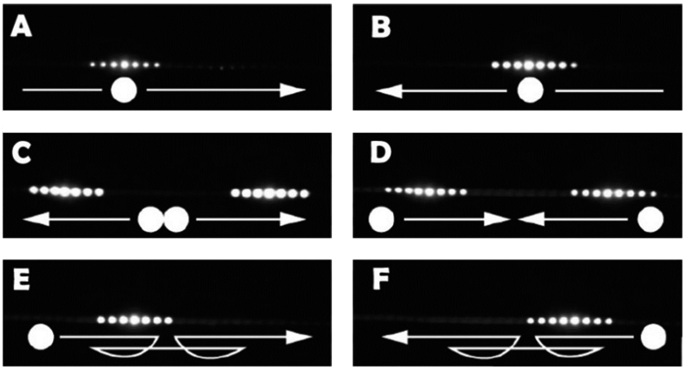

Fig. 3. Six patterns in which lights move in a horizontal direction

Initially, each participant observed the six different lighting patterns. Then, each participant evaluated the following five items related to “impression” and “motivation”: (1) level of feeling of wanting to move your body, (2) level of feeling of wanting to get closer, (3) level of feeling of being in danger, (4) level of perception of beauty, and (5) level of preference. In the final step, each participant ranked each of the six different lighting patterns based on the five evaluation items.

2.2 Results of Evaluation Experiments

The results of the two experiments were analyzed using the Normalization Ranking Method (NRM), which is a method of ranking and comparing visual stimuli to each other. NRM is less difficult for the participant than the paired comparison method. Moreover, NRM is easy to use when conducting an experiment due to the small calculation amount for analysis [6].

Level of Feeling of Wanting to Move Your Body. From the results of the experiments, the F pattern, which involves very complex and random movements, was most highly evaluated for the ‘level of feeling of wanting to move your body.’ Conversely, A and B, which involve the simplest movements, were evaluated as the lowest in the same evaluation item. Figure 4 illustrates the results of the evaluation (Fig. 5).

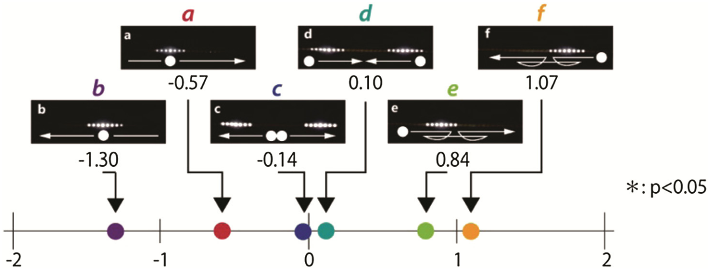

Fig. 4. Results of evaluation in the level of feeling of wanting to move your body

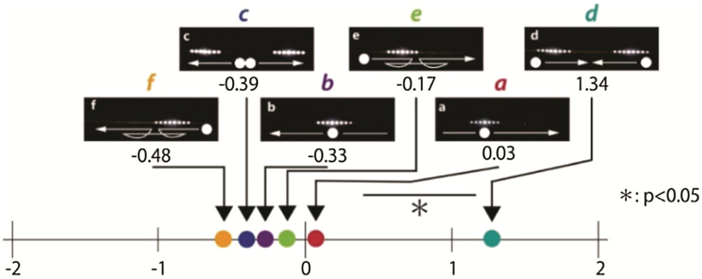

Fig. 5. Results of evaluation in the level of level of feeling of wanting to get closer

Level of Feeling of Wanting to Get Closer. In the evaluation item of 'level of feeling of wanting to get closer,' the D pattern, in which two lights emerge from the left and right sides simultaneously and move into the center, was most highly evaluated.

Level of Feeling of Being in Danger. In the evaluation item, 'level of feeling of being in danger,' the E pattern, which is a complicated movement contrary to the natural flow, was most highly evaluated. Conversely, A and B, which involve the simplest movements, were evaluated as the lowest in the same evaluation item. Especially, the lighting of the B pattern, which flows very simply and naturally, was lowest in the evaluation (Fig. 6).

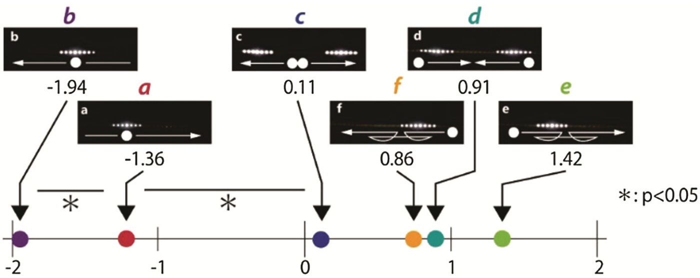

Fig. 6. Results of evaluation in the level of feeling of being in danger

Level of Perception of Beauty. In the evaluation item, 'level of perception of beauty,' the C pattern, in which two lights emerge from the center, and each light group moves to the left and right, was most highly evaluated. Conversely, E and F, with their complex and random movements, were evaluated as the lowest in the same evaluation item (Fig. 7).

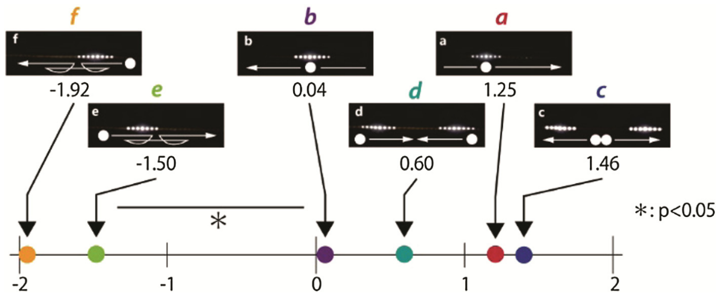

Fig. 7. Results of evaluation in the level of perception of beauty

Level of Preference. In the evaluation item, 'level of preference,' the D and C patterns were most highly evaluated. However, E and F, with their complex and random movements, were evaluated as the lowest in the same evaluation item (Fig. 8).

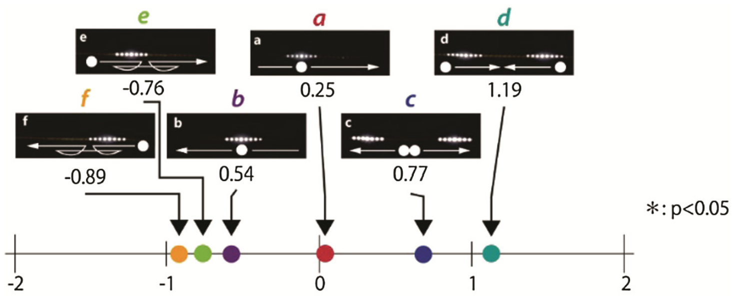

Fig. 8. Results of evaluation in the level of preference

3 Proposal for an Affective Skateboard Named "Glowboard"

Based on the above experimental results, we proposed a new skateboard named "Glowboard" (Fig. 9). The lower part of the skateboard is always in shadow despite daytime brightness. Especially, the light of the LED can be seen not only at night but also during the day or in a bright environment. Because the light of the LED on the lower part of the skateboard is conspicuous, LED serial tape was attached to the lower backside of the skateboard.

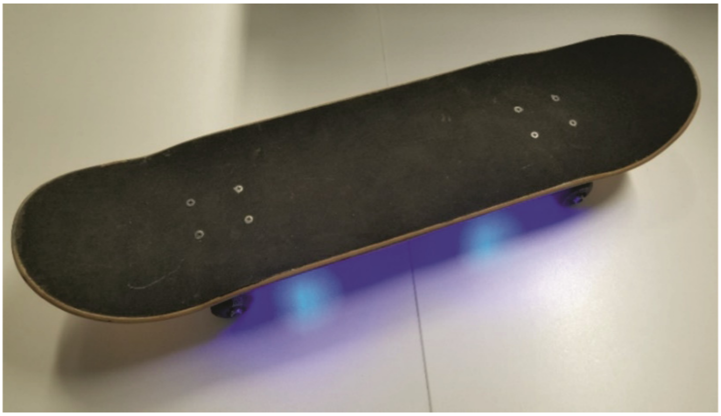

Fig. 9. "Glowboard"

For the "Glowboard" proposal, a skateboard, an Arduino UNO system, a non-contact rotation speed sensor (OH 182/E), LED serial tape, and a battery supply system were used (Fig. 10).

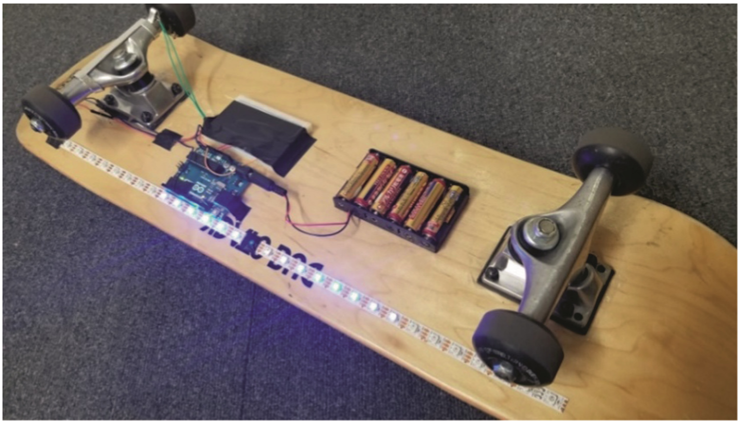

Fig. 10. Basic construction of the "Glowboard"

The mechanism of the "Glowboard" changes the light patterns according to speed changes of the user on the skateboard. The non-contact rotational speed sensor (Fig. 10) records the amount of change in the magnetic field in front of the sensor. A neodymium magnet is embedded in one front tire (Fig. 12); this sensor measures how many times the tire rotates based on the level of neodymium magnet. The programed Arduino Uno system acquires the measured amount of change in rotation as information on the speed of the skateboard per unit of time. The value obtained from the non-contact rotation speed sensor is converted to an easy-to-use value, and how much it changes in relation to a unit of time (in this case, the count exceeded 45 times) is measured (Fig. 11).

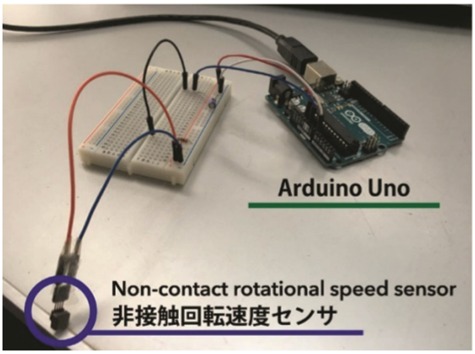

Fig. 11. Arduino Uno system and non-contact rotational speed sensor

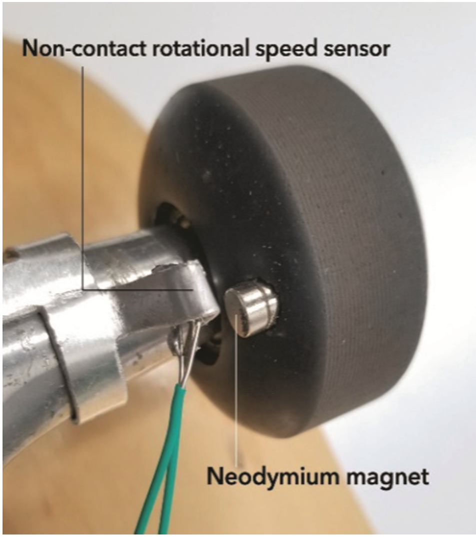

Fig. 12. Non-contact rotational speed sensor and neodymium magnet

In the next step, based on the obtained measured value, the programmed Arduino Uno system decides how to change the lighting pattern according to the evaluation experiments. In other words, the measured result is used as a value for switching the light conditions of the "Glowboard."

The "Glowboard" displays the following five blinking and moving patterns with different colors of light depending on the rotation speed of the skateboard's tire:

1. Stopped condition: D pattern with blue color. The D pattern was most highly ranked at the level of feeling of wanting to get closer.
2. Low speed condition: F pattern with green color. The F pattern was most highly ranked at the level of feeling of wanting to move your body.

3. Stable speed condition: B pattern with white color. The B pattern was evaluated as average in most evaluation levels. Furthermore, this pattern was the lowest at the level of feeling of being in danger.
4. High speed condition: C pattern with blue color. The C pattern was most highly ranked at the level of perception of beauty and ranked 2nd at the level of preference.
5. Too high-speed condition: E pattern with red color. The E pattern was most highly ranked in level of feeling of being in danger.

Figure 13 shows the five lighting patterns of the "Glowboard."

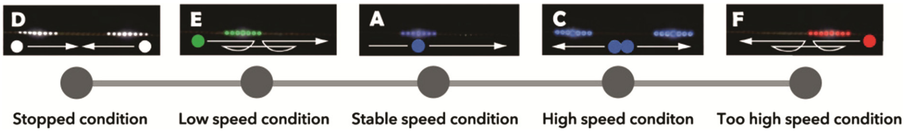

Fig. 13. Five lighting patterns of the "Glowboard"

4 Evaluation of the "Glowboard"

The evaluation experiment for the "Glowboard" was conducted with eight participants at Future University Hakodate on January 19, 2017. Eight participants watched a skater ride the "Glowboard" with its various lighting patterns, and a regular skateboard without any lighting pattern at random. They were allowed to touch the "Glowboard" directly. Afterward, each participant freely noted good points and bad points using a questionnaire. Table 1 shows some selected results of the questionnaire.

Table 1. Some opinions obtained from the questionnaire

Good points	"Glowboard" helps to develop skateboard performance
	"Glowboard" may become a new sport/exercise
	The colored light pattern helps to obtain rich information
	"Glowboard" can help to evaluate a skater's skill
	"Glowboard" may be useful at the show level also
	A parent can check their child's skills on the skateboard
	"Glowboard" prevents some accidents related to speeding
	It is easy for users to ride and check their skateboard purpose levels
	It is very fun to see the various light patterns
Bad points	There is no algorithm governing how the light colors change
	Sometimes the board movement direction and light movement direction were not linked
	The light color change time was too fast
	For the skater, it is difficult to see one's own light patterns

From the evaluation experiment with the "Glowboard," we found that the various light patterns are effective not only for developing skating performance but also for evaluating skaters' skills in skateboarding competitions. The results illustrate that the "Glowboard" is effective for increasing users' enjoyment. However, there are some points that must be developed in relation to the movement pattern and color variation through a logical research process.

In the future, it will be necessary to clarify the impression made and influence of the different light colors on enjoyment. The "Glowboard" will be developed using a wider variety of light patterns based on the results of further study.

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