A Study on Flashing Light of Personal Mobility

- Focusing on Kansei Evaluation of Blinking Pattern -

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ABSTRACT

The Personal mobility without power such as bicycle and kick board is used by many people because of its ease. Bicycles are an important means of transportation that accounts for 13% of Japan's share of transportation, but it cannot be said that safety is adequate. The total number of traffic accidents in Japan decreased by 30% from 2002 to 2012, while the bicycle to pedestrian accident increased to about 30%. This may be due to carelessness due to a walking smartphone or a change in traffic conditions due to a bicycle boom. In response to this, interest in "bicycle and safety" is rising in Japan. Currently, a method of sounding a horn such as a bell is common for communication between a bicycle and a pedestrian. However, it is forbidden to use other than "when it is unavoidable to prevent danger" by the Road Traffic Law, so it should not be ringed for the purpose of urging pedestrians to perceive themselves, and there are limits to sound communication. Therefore, we focused attention on a method to increase cognition from pedestrians by using flashing lights. However, flashing lights currently sold only repeat flashing on and off, there is no uniformity in flashing specifications. According to the questionnaire conducted, people were seen as negative images such as "indecent" or "scary" against "the impression from the flashing light". By investigating and eliminating the negative factors included in the blinking, it is necessary to study ways to adopt more cognitive communication. The purpose of this research is to investigate a new blinking pattern that can maintain communication with little stress while maintaining recognition of pedestrians and bicycles. As a research method, we examined existing accident prevention goods and grasped and classified the used products. Next, we selected experimental requirements, built a flashing device, measured the time to notice the flashing, and investigated whether there is any difference in awareness. After that, we conducted a verification experiment and analysis, investigated the impression difference received from the blinking light, and trial-produced a blink pattern.

Keywords: Personal Mobility, Blinking Pattern, Light Interaction, Kansei Evaluation

1. Introduction

Personal mobility provides many people ease and pleasure. In Japan, bicycles are an especially important means of mobility that accounts for a 13% share of transportation. However, it cannot be said that safety is sufficient, due to carelessness with smartphones and changes in traffic conditions. Currently, bicyclists and pedestrians generally communicate with each other by sounding a bell, but because of the Road Traffic Law, using a bell other than "when it is unavoidable to prevent danger" is forbidden. Originally, the bell was not sounded to encourage pedestrians to recognize, so I thought communication by sound was limited. Therefore, we focused on a method to increase pedestrians' cognition by using flashing lights. However, the flashing lights currently sold only flash on and off repeatedly, and their flashing specifications have no uniformity. Furthermore, according to the questionnaire conducted, people were seen as negative images, for instance, “indecent” or “scary” against “the impression from the flashing light.” More cognitive communication seems to require investigation and removal of negative factors in blinking lights. Thus, this research's purpose was to investigate a new blinking pattern that can maintain communication with little stress, while also allowing recognition of pedestrians and bicycles.
2. Research Method

This research follows the following procedure:

1. Investigate existing accident prevention goods; grasp and classify products used.
2. Select experimental requirements and production of the flasher.
3. Measure response time to notice blinking and investigate any difference in noticeability.
4. Experiment: Analyze and investigate differences in impressions received from flashing lights.
5. Develop a prototype Blinking Pattern.

3. Results

Some descriptive statistics of the five dimensions above reflected a change in ergonomics research activities.

3.1 Survey on current situation of accident prevention goods

We surveyed the existing products installed for prevention of bicycle accidents. Mainly, five kinds of products are used, and these were divided into three categories: “Products for not fighting accidents,” “Products for avoiding accidents,” and “Products for both purposes.” Figure 1 is a diagrammatic representation of the classification and mounting locations. Flashing lights and headlamps are distinguished from the viewpoint of application and road traffic law; flashing lights are classified as products for not causing, or avoiding, accidents.

Table 1. Experimental Requirement

| Requirement                                    | Specification                                      |
|------------------------------------------------|----------------------------------------------------|
| Brightness of LED light                        | 150~200lm                                          |
| Surrounding brightness                         | 5~50lx                                             |
| Distance between LED lights and the subject    | 10m                                                |
| Blinking time                                  | 4.0s                                               |
| Blinking cycle                                 | 0.1~1.5s                                           |

3.2 Selection and creation of requirements for Blinking Pattern

The experimental procedure was as follows: The pedestrian subject looks at a smartphone. When 50 to 120 s have elapsed from the experiment’s initiation, the LED light is flickered from behind the subject toward her/his feet. The subject declares when s/he perceives the blinking. The experiment finishes at that point.

This situation is filmed with a camera, and the time from the flashing’s start to subject awareness is observed from the camera’s image. This is repeated with each of the eight blinking patterns, and the time from the start of blinking to the reaction is examined.

[Subjects] 3 men, 4 women (18–22 years old)

![Figure 1. Installation position and application of accident prevention goods](image)
Based on this, PWM output reproduced a total of eight blinking patterns—seven typical blinking light patterns and one pattern of constant light without blinking. In all flashes, the color was white, and Arduino was used for production. Fig. 3 shows temporal change in luminance expressed as a waveform.

### 3.3 Investigation of Reaction Time

We conducted experiments with seven boys and girls to investigate differences in reaction times for noticing blinking patterns. Table 1 shows the average time and standard deviation required for the seven subjects’ reactions. Results showed that any pattern was noticed within 4.0s. Additionally, there was no difference among patterns except for pattern A’s constant light.

In addition, when B, D, E, and H patterns arose early, reaction time tended to be shorter.

### Table 2. Time required for Reaction

| Pattern | A (s) | B (s) | C (s) | D (s) | E (s) | F (s) | G (s) | H (s) |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1       | 0.98  | 0.82  | 0.72  | 1.11  | 0.60  | 1.06  | 1.00  | 0.92  |
| 2       | 0.98  | 1.03  | 1.38  | 0.60  | 0.79  | 0.91  | 1.02  | 0.71  |
| 3       | 1.16  | 1.04  | 1.09  | 1.12  | 0.80  | 0.60  | 0.64  | 0.42  |
| 4       | 1.11  | 0.77  | 0.79  | 1.31  | 1.02  | 0.11  | 1.10  | 1.23  |
| 5       | 1.38  | 0.75  | 1.78  | 1.24  | 0.97  | 1.20  | 0.75  | 1.11  |
| 6       | 1.75  | 2.21  | 3.41  | 1.90  | 2.35  | 1.40  | 3.14  | 1.53  |
| 7       | 0.81  | 1.18  | 1.46  | 0.86  | 1.29  | 0.90  | 1.10  | 0.96  |

### 3.4 Kansei evaluation by SD method

A questionnaire on impressions of receiving each blinking pattern was conducted with 18 males and females, using seven stages of the SD method. Figure 5 is a graph of the difference in participants’ impressions by blinking pattern, beginning from C, based on Kansei evaluation results. Results showed the following:

- The presence or absence of blinking is related to change in the perceiver’s emotion.
- The faster the blinking cycle, the greater the impression received.
- A positive impression is more easily given by changing the blinking’s smoothness.
- Change in rhythm does not affect change in impression.
4. Conclusion

In this research, we examined the blinking pattern to maintain the perceptibility of bicycle flashing lights. As a result, when we investigated people's attitudes toward flashing lights, it turned out that the flashing light has a positive side that is functional and a negative side that is annoying and scary. Before conducting the impression evaluation, in order to confirm the superiority as a cognitive product of small mobility, we conducted an experiment to investigate the awareness of each blinking pattern of the flashing light. In doing so, by making the blinking light using Arduino, to conduct more highly reproducible experiments as compared with the previous study "blinking pattern evaluation method based on sensitivity index for improving the visibility of LED warning light" I made it. As a result of the experiment, although there was a slight difference for each blinking pattern, since all the patterns fell within the reference value, it was judged that there was superiority as a cognitive product of small mobility, and the impression was evaluated and the following I found out.

- The impression received from the light varies depending on the presence or absence of blinking.
- It makes a positive impression by making the blinking smooth.
- Impression does not change with change of rhythm.
- The way in which blinking rises is due to the impression of kindness.
- The manner in which the blinking disappears is caused by the psychological sense of distance.

Acknowledgements

In this research, we made Blinking Patterns for bicycle lights, investigated reaction times, evaluated the Kansei, and examined necessary elements for a new Blinking Pattern. Next, we should clarify the relationship between blinking and light color, and increase the light's effectiveness.

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