# A Study on the Visibility of the Light Emitting Braille Block

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**Abstract.** About 60% of the visually impaired people are low-vision. Light-emitting textured paving block by using LED is developed to support the mobility of such visually impaired because such block is considered to be effective for notifying specific places such as the entrance, the exit, and so on to the weak eyesight people in the night. This block uses the innovative lighting mechanism by which extremely long-life light emission by using the battery is enabled. So far, there is no report on the visibility of the LED by using this mechanism. Therefore, in this paper, we report the result of the preliminary experiment for evaluating the visibility, and discuss on the trade-off between the visibility and the electric consumption.

**Keywords:** Low-vision, Light-emitting textured paving block, LED, Visibility.

## 1 Introduction

There are about 310,000 visually impaired in Japan. Visually impaired people are not necessarily total blindness, because about 60% of them are weak eyesight. For the persons who have visual impairment, walking guide is general requirement. To fulfill the requirement, many high-technology solutions including wearable devices [1].

The Braille blocks had invented originally by Mr. Miyake who lived in Okayama Prefecture in 1965. Two years later, 230 blocks were paved around a school for the blind in Okayama. After that, the blocks were spreading everywhere. Though there are several arguments that these blocks are not useful for wheelchair users, they became already necessary infrastructure for the blind persons living in Japan.

Figure 1 is an example of the visually impaired people's' view. Therefore, the light-emitting textured paving block ensures the security of the night walk of the people with such weak eyesight, and is used to notifies the specific places such as the entrance, the exit and so on (Figure 2).

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The block shown in Figure 1 uses the LED as the light source, and the innovative lighting mechanism enables it to emit light for extremely long period of time by using the battery. This technology will be assumed what is applied to various public signatures in future (Figure 3).

There is also a report on programmable light-emitting Braille blocks by using LED [2]. These blocks have each ID number and its luminance can be controlled in eight levels. Most remarkable feature is that the program which controls illuminating timing and the brightness is rewritable. By that feature, these blocks became an emergency guide system by changing the animation patterns.

However, there is no evaluation report on the visibility of such light-emitting Braille block for the people with weak eyesight. Therefore, we conducted the preliminary experiment for evaluating the visibility. In this paper, we report the result of the preliminary experiment for evaluating the visibility, and discuss on the trade-off between the visibility and the electric consumption. And there are already many studies of the walk support of weak sight person [ 3]- [ 5].

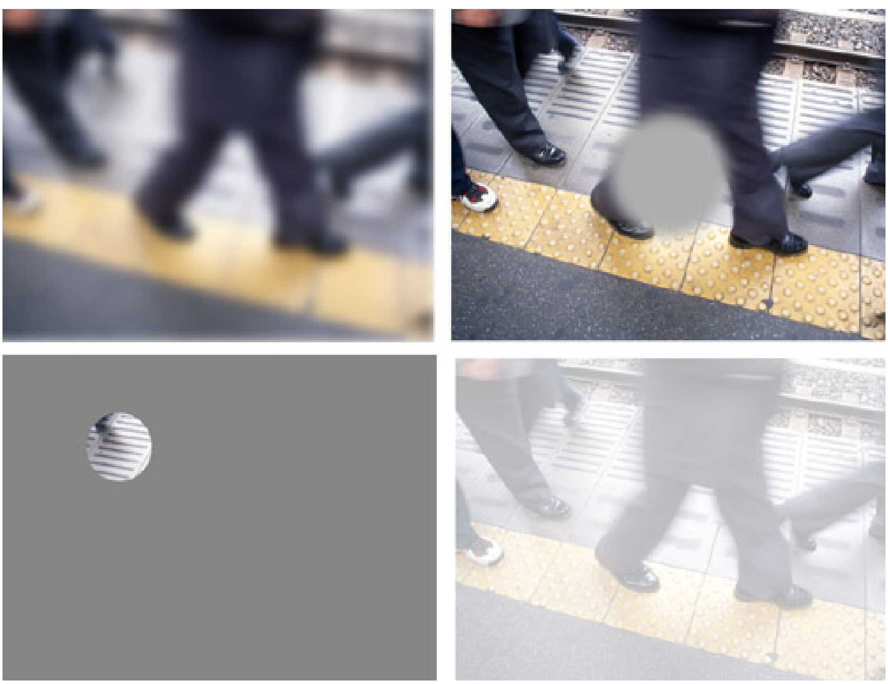

**Fig. 1.** Example of weak sight person's view

**Fig. 2.** Example of light-emitting textured paving block by using LED


**Fig. 3.** Example of public sign that shows no smoking area

## 2 Light-Emitting Textured Paving Block by Using LED

Figure 4 shows the lighting mechanism of LED that enables the long-life light emission by using the battery. A is installed in the places such as road surfaces catching the strong vibration. Therefore A is driving by a battery to decrease risks such as the disconnection. It is well-known that the brightness of the LED depends on the steep of the rising edge of the electric current in the LED (Broca-Sulzer phenomenon) [6].

In order to generate such electric current, the tantalum condenser is used because of its low internal electric resistance. The high-speed switching transistor enables to charge and discharge it in an extremely short time. By making the interval of this cycle shorter than the critical fusion frequency of human, people perceive only one blight blink rather than several dark blinks. We can control the brightness and the electric consumption by

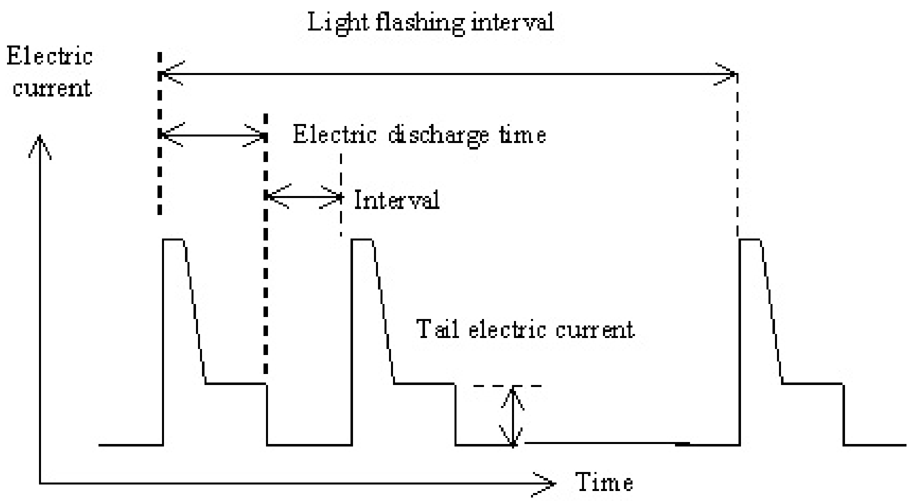


**Fig. 4.** Lighting mechanism enabling long-life light emission by using battery

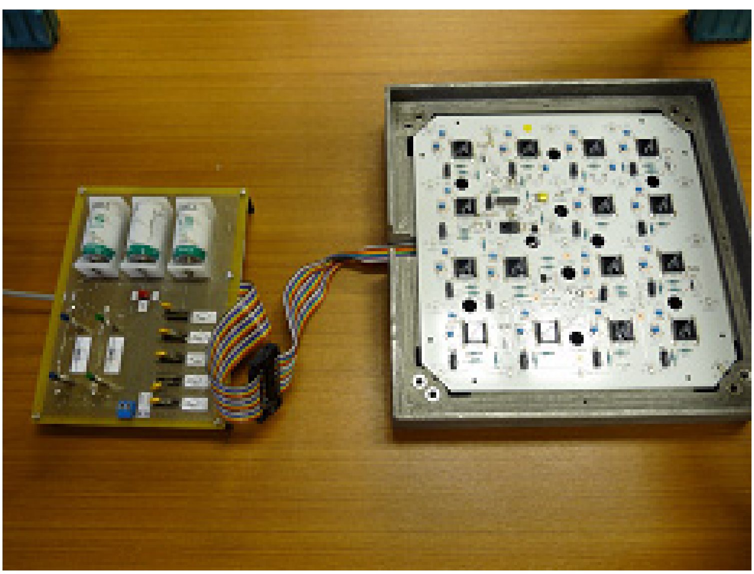

**Fig. 5.** Circuit board of paving block by using LED

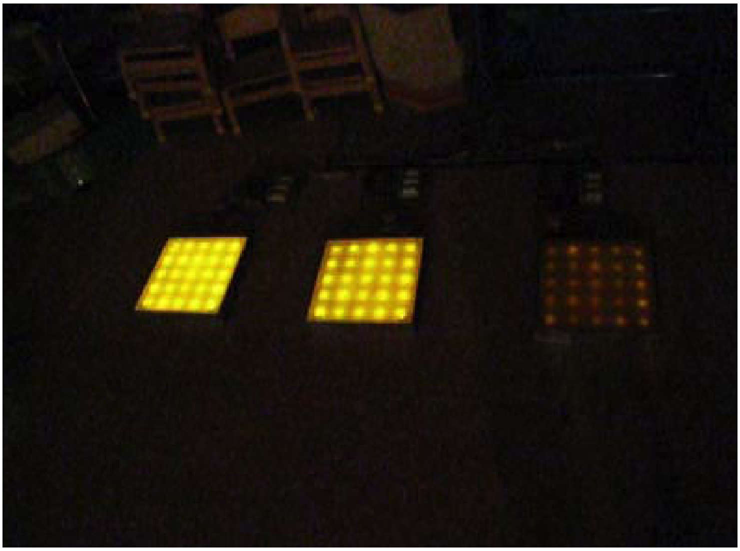

**Fig. 6.** Appearance of flashing of block in laboratory

changing the interval of the blinking and the number of the blinks, but so far, it remains uncertain which combination of these parameters are the best in terms of both the visibility and the electric consumption. Figure 5 shows the circuit board which we used for this evaluation, and Figure 6 is appearance of blocks' flashing. The number of times of the light flashing is once twice three times from the left.

## 3 Experiment 1

### 3.1 Method

In this experiment, I controlled this parameter and experimented on evaluation of the visibility by the physically unimpaired person. The subjects of this experiment were nine students of Kyoto Institute of Technology. And an experiment place is a classroom of Kyoto Institute of Technology, and all of them are normal eyesight.

The experiment was conducted in a room surrounded in a blackout curtain. The block has 25 LEDs, but we covered LEDs except the center one. Subjects could observe the blinks of the LED at the center of the block. The fluorescent lamp of 100W was set above the LED. We gradually lowered the height of the lamp position. Accordingly, the surface of the block became brighter, and perceiving the blinks of the LED became difficult. When subjects could not perceive the blinks of the LED, we measured the illumination of the block surface as the visibility of light-emitting Braille block. (Figure 7).

The subject stood at 90cm apart from the block. Three patterns of the interval of the charge and discharge were tested: 2.5msec, 7.5msec, and 25msec, and three patterns of the number of times were tested: one, two, and three. On each combination of the interval and the number of time of charge and discharge, we measured the illumination mentioned above three times per subject.

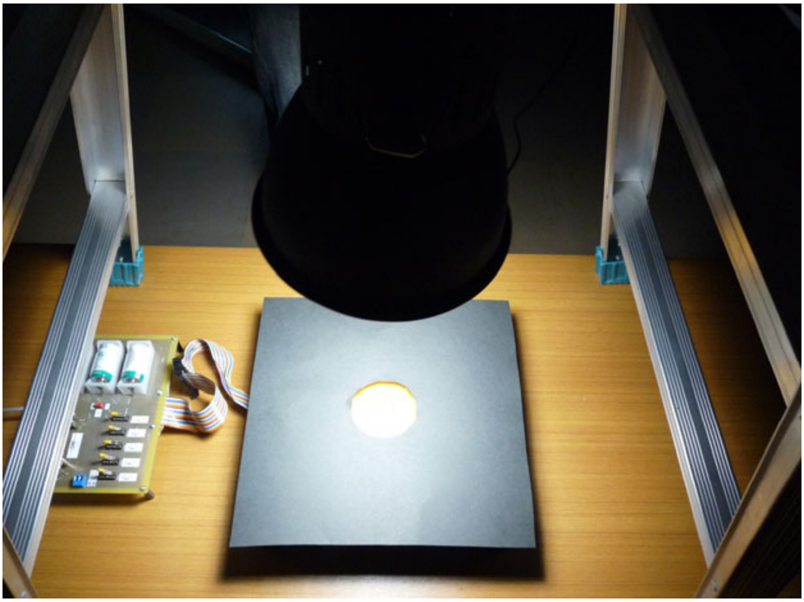

**Fig. 7.** The machine parts which used for an experiment by the physically unimpaired person

### 3.2 Result

Figure 8 shows the experimental result. When the interval was 2.5 msec, the luminance of the block surface when subjects could not perceive the LED blinks increased according to the number of time of charge and discharge. There was the significant difference between each result on the number of time in this interval.

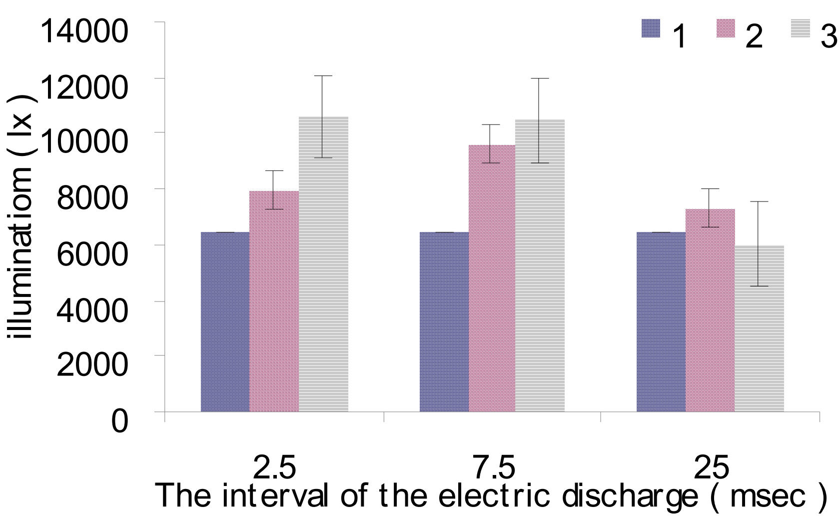


**Fig. 8.** Average of the luminance of the block surface

However, when the interval was 7.5 msec, there was no significant difference between two and three times of charge and discharge. Furthermore, when the interval was 25msec, there was no significant difference between one, two, and three time. Therefore, in order to gain sufficient visivility even in the daytime outdoor shade (about 10,000 lx), the best trade-off point is to charge and discharge electricity twice at 7.5msec interval.

## 4 Experiment 2

### 4.1 Method

In this experiment, the method was the same as Experiment 1, but the subjects were weak sight persons. The number of the subjects was twenty, but There were the subjects who had a difficulty to find the blinking of the LED due to the severe tunnel vision. Also, there were the subjects who could not perceive the blinking of the LED even in the lowest illumination condition of our experimental setup. Therefore, only nine subjects could complete this experiment.

### 4.2 Result

Figure 9 shows the experimental result. There was no significant difference between the results of the number of time of charge and discharge in every case of the interval of the electric discharge. It also shows that weak sight person could not perceive the LED blinking at about one quarter of the luminance in comparison with the normal vision person even though they could find the position of the blinking LED. Almost all subjects developed severe tunnel vision. They lost not only the most of the visual field, but also the sensitivity of their retina due to the disease. Furthermore, their cornea, lens, and vitreum might have become opacified.

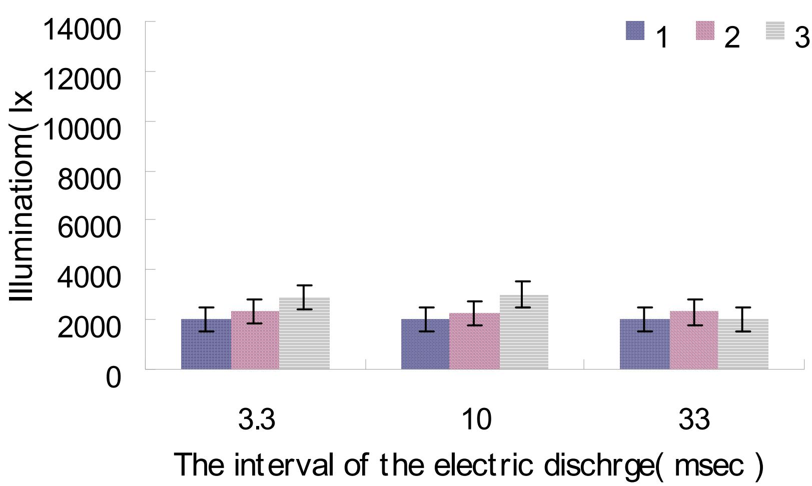


**Fig. 9.** Average of the luminance of the block surface

**Fig. 10.** Flashing of block of various colors

## 5 Conclusion and Future Works

According to the experimental results of the subjects with normal vision, increasing the number of times of charge and discharge increased the visibility of the LED when the interval was 2.5msec and 7.5msec. On the other hand, when the interval was 25msec, increasing the number of times of charge and discharge had no effect for increasing the visibility. Furthermore, when the interval was 7.5msec, there was no significant difference between two and three times of charge and discharge. In terms of the trade-off between the visibility and the electric consumption, setting the interval to 7.5msec, and setting the number of times to two is the best in this preliminary experiment.

On the other hand, the result of the weak sight subjects showed no significant difference between every combination of the parameters, although it indicated the same tendency as that of people with normal vision.

As for the future works, we would like to evaluate the visibility of the LED under the condition where the parameters are controlled more flexible, because we tested very limited combination of the parameters due to the hardware constraint. We are developing the new board for this purpose. Also, we would like to examine the effect of the block color to the visibility by using the light-emitting Braille blocks of other colors as shown in Figure 10.

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