

# Proposal of New Lighting Which Combined Functionality of Street Light and Outdoor Light

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**Abstract.** The two types of illuminations were developed as security sensing with motion sensor instead of the image. We focused on the lights in outdoor in this study. As the role of outdoor lights, the proposed light has a function that feels natural presence of residents and pedestrian light as illumination. We examined about a new style of lighting and proposed the lighting which combined functionality of street light and outdoor light. We conducted concept planning, prototyping, experiments for determining flash lighting and evaluation, and proposed two design models. The proposed lightings in this study were able to provide a solution by data and sensing, and to achieve safety and security.

**Keywords:** Lighting for safety and security · Sensing · Light-emitting pattern · Street light · Outdoor light

## 1 Introduction

Lighting has not only a role that illuminate objects but also a psychological effect. For example, Lighting gives comfort and relief to people. As the light of outdoor, there is the role of the security and psychological to ease the fear of not visible in the dark or at night. In this way, lighting is an important element in our life.

Therefore, we focused on the lights in outdoor in this study. As the role of outdoor lights, the proposed light has a function that feels natural presence of residents and pedestrian light as illumination. We examined about a new style of lighting and proposed the lighting which combined functionality of street light and outdoor light.

## 2 The Lighting for Safety and Security

The brightness of the outdoor lights at night in Japan show the development of civilization and culture, and it is believed to symbolize the modern life. In particular, such as convenience stores and signs not only outdoor lights illuminate brightly the town in

urban areas. People are able to live without being aware anxiety coming from the night darkness. However, such brightness is inhibited that feel the original of calm on the town and natural signs. This is different from the Japanese seems sensibility.

In “In Praise of Shadows”, Junichiro Tanizaki, one of the most eloquent Japanese novelist described essential difference between Japan and the West, was pursuing the essence of Japanese beauty within the shadows and dark circles. In this way the shadows not only the brightness are present Japanese beauty.

The illumination products, not only light up at all times illumination for safety and security features. This utilizes the sensing technology, has the light-emitting pattern and a motion in the equipment, and is fused features on street lights and outdoor lights. This report proposed new lighting with a fusion of these features.

The concept of safety and security was provided in two axes. The first axis was ordinary and extraordinary. The second axis was reassurance and anxiety. We investigated the safety by superimposing level of feeling for these axes. As a result of examination, we had defined two types, type A and B.

- Type A: Lighting that provides the comfort and reassurance in daily life.
- Type B: Lighting that possess the function of the alarm in order to reduce anxiety in a non-daily state.

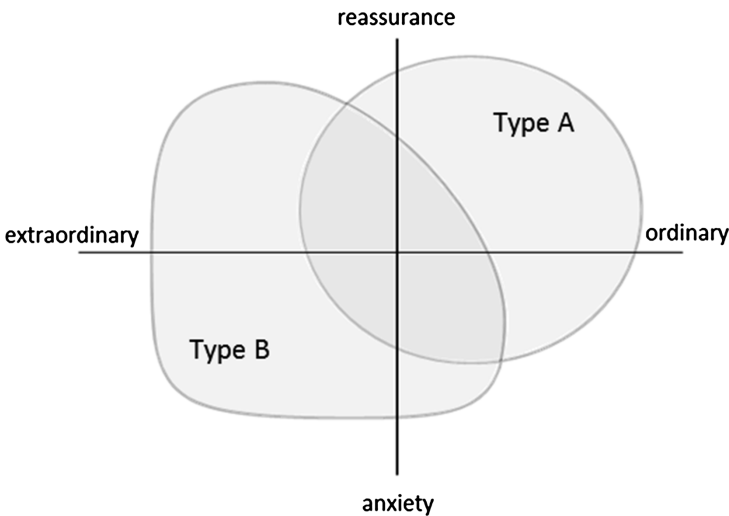


Fig. 1. Concept of illumination

These have the function to react to the movement as a sensor technology and represent a comfort or dangerous condition by way of the reaction. Moreover, these incorporate the weather data like temperature, humidity, rain, and wind, as an environmental sensor technology. These lighting have the role of information presentation tool.

### 3 Concept

The concept of developed illumination product is to respond the human motion by sensing technology and to have the watching illumination as function.

This lighting has the functions which feel reassurance like illumination, sensing the strange motion and intruder by motion sensors and do emission in accordance with the abnormal state of the attention to the warning (Fig. 1).

### 4 System Concept

The system concepts are the following two points.

- Light-emitting pattern and the illumination equipment by sensing device are operating, lighting range is changed.
- Provide information to the town security system, and operate to have a function as a security sensor in the street.

### 5 Sensing and Feedback Pattern

The proposed product is to apply the sensing technology, in cooperation with big data and home energy management system (HEMS), can provide information as Fig. 2. In addition, the feedback, including the cooperation with the community as illumination was defined as Fig. 3.

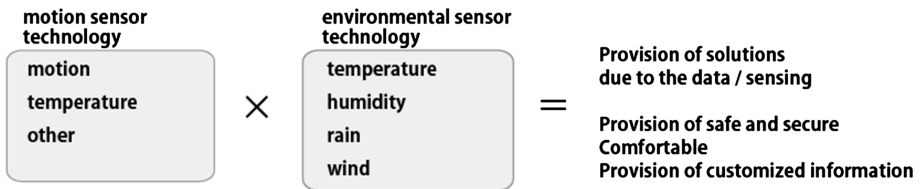


Fig. 2. Sensing

## 6 Lighting-Emitting Patterns and Impression Evaluation

### 6.1 Purpose

There are two purposes for evaluation. At first, the purpose was to determine the threshold on the flashing frequency value for reassurance/danger (Exp. 1). The next purpose was to examine the physiological response and impression evaluation for comfortable, attention, and warning conditions (Exp. 2).

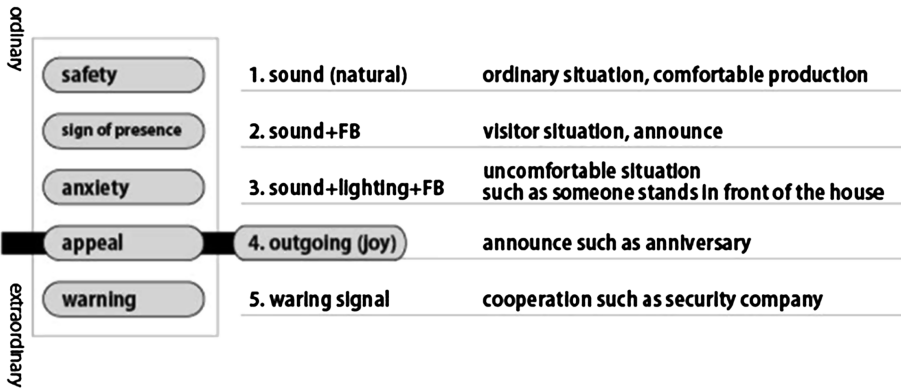


Fig. 3. Feedback and feeling

## 6.2 Methods

### 6.2.1 Presentation Conditions

Exp. 1: The flashing frequency value for reassurance/danger determined the threshold by up-down method.

Exp. 2: The presentation conditions were 9; 3 comfortable conditions (C1-C3), 3 attention conditions (A1-A3), and 3 warning conditions (W1-W3). Presentation time was 1 min for comfortable conditions, 30 s for attention conditions, and 15 s for warning conditions. However, experimenter informed consent to the participants. The experimenter told the participants to close eyes when the participant feel “feel bad” or “eye hurts”, and decided to interrupt the experiment.

### 6.2.2 Measurement Indices

The measurement indices on Exp. 2 were galvanic skin response (GSR) and electrocardiogram (ECG) as physiological responses. The integral value of every second was calculated for GSR, and LF/HF was calculated by frequency analysis for ECG. Impression was evaluated using 8 items by visual analog scale (VAS) (Table 1).

Table 1. .

warm	feel relief
strong	bright
humaneness	natural
scary	feel danger

### 6.2.3 Experimental Procedure

The experimental procedure was rest for 1 min, presentation of a condition and evaluation. This procedure was repeated for 9 conditions. At last, the experimenter interviewed to participants (Fig. 4).

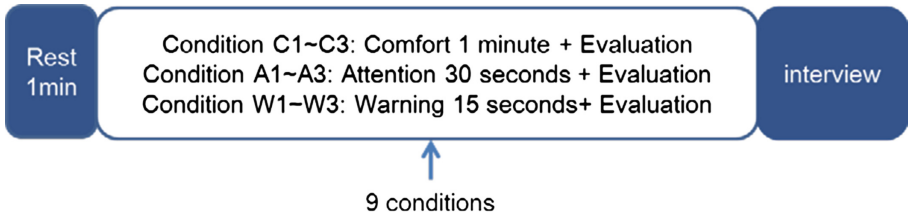


Fig. 4. Experimental procedure

6.2.4 Participants

The participants were ten person (7 males and 3 females). The average age were 22.4.

6.3 Results

6.3.1 The threshold on Exp. 1

The threshold for reassurance/danger on flashing of light was examined by up-down method. As the result, frequency of threshold was  $1.21 \pm 0.135$  Hz. This value was with reference, presentation conditions of Exp. 2 were created.

6.3.2 GSR

The presentation time for warning conditions was 15 s, therefore the first 15 s for comfortable and attention conditions were analyzed.

The ANOVA for conditions was performed to examine the difference between conditions. There was no significant difference on 9 conditions, however integral value for GSR was high on attention conditions and the sympathetic nerve tended to activate (Fig. 5).

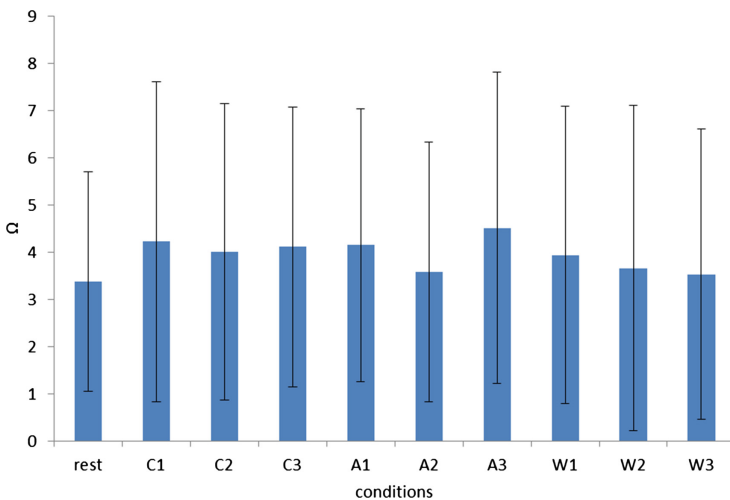
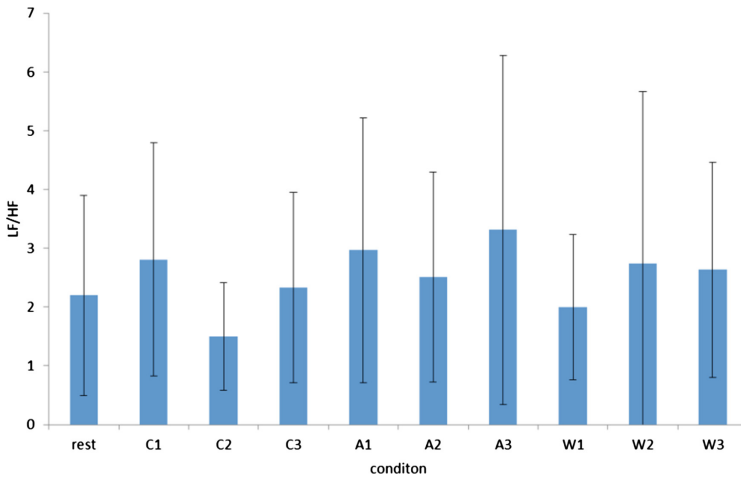


Fig. 5. Result on GSR

**6.3.3 LF/HF**

The presentation time for warning conditions was 15 s, therefore the first 15 s for comfortable and attention conditions were analyzed similar to GSR.

The ANOVA for conditions was performed to examine the difference between conditions. There was no significant difference on 9 conditions, however LF/HF on C2 of comfortable condition was low, in other words, the parasympathetic nervous was activated. On the other hand, LF/HF on A3 of attention condition was high, sympathetic nervous was activated (Fig. 6).



**Fig. 6.** Result on LF/HF

**6.3.4 Impression Evaluation**

Figure 7 shows the results of VAS evaluation on 8 items. As the results of ANOVA for conditions, there were significant differences on conditions with the exception of “humaneness”. Therefore, multiple comparison was occurred to examine the differences between conditions. There were significant differences between comfortable and warning conditions.

**6.4 Discussion**

The threshold which felt safe and dangerous revealed to flash illumination from this experiment, and obvious differences were observed in the impression evaluation of flashing pattern which presented comfortable, attention and warning. Moreover, it was possible to find the potential effects on the autonomic nervous activity appeared.

In presentation conditions of this experiment, same condition, i.e., comfortable condition had C1-C3, 3 kinds of patterns were presented. The impression changed by not only flashing frequency but also patterns and the effects of physiological response were recognized. Therefore, these proposal products have possibility to apply the

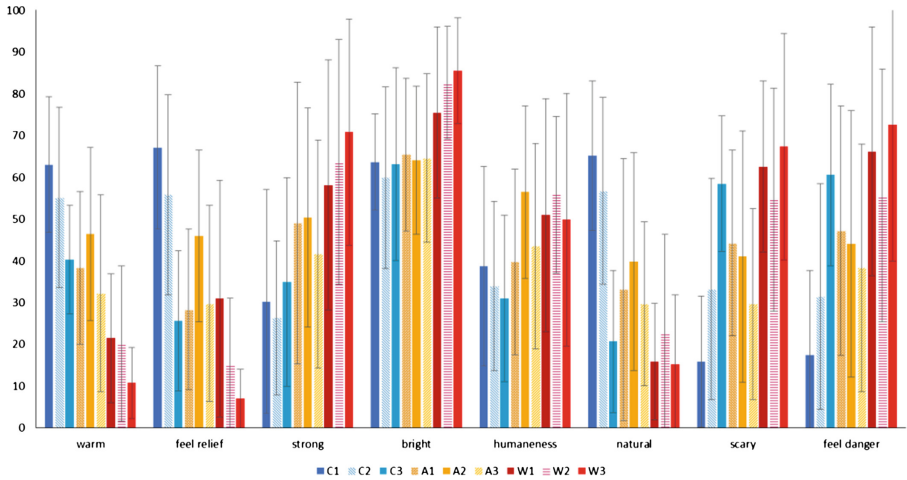


Fig. 7. Impression evaluation on 9 presentation conditions

environment and situation as illumination equipment and the concept of illumination need to be clarified.

In this study, we applied the 9 conditions, and designed lighting of two types of following.

## 7 The Two Design Models

### 7.1 Design Model A

The design model A is the lighting equipment with the function as fence and with light-emitting pattern for security with motion (the left on Fig. 8).

### 7.2 Design Model B

The design model B is the lighting equipment with the function as foot light and with light-emitting pattern for security (the right on Fig. 8).

## 8 Conclusion and Future Works

The two types of illuminations were developed as security sensing with motion sensor instead of the image. We conducted concept planning, prototyping, experiments for determining flash lighting and evaluation, and proposed two design models.

The proposed lightings in this study were able to provide a solution by data and sensing, and to achieve safety and security. It is possible to provide customized information, they can be expected to be deployed in public spaces as well as residential area. As the application of these lights, they will have a function as a watch and protect

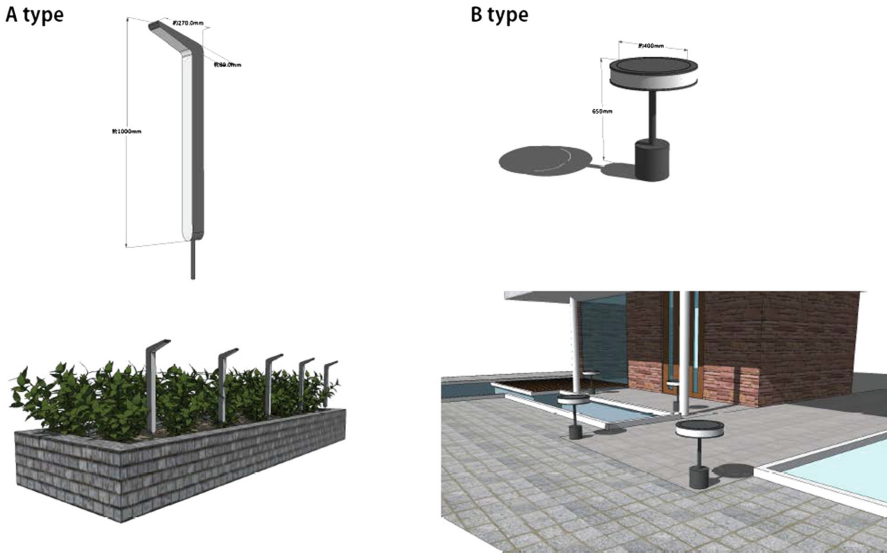


Fig. 8. Design model A and B

device that can accommodate a variety of situations by taking advantage of other sensor technology.

These will be not only a function of the light that lighting, these lead to visualization of safety and security in cooperation with the sound and HEMS. Moreover, in future possibility, it can be performed to improve the energy efficiency in the home by considering the external situation in cooperation with HEMS (Fig. 9). In addition, it is possible to check the status of HEMS using smartphone and to grasp the situation around the house even from a remote location. It is possible to measure the environment in the area by combining the city of sensing data (Fig. 10) and to provide services such as pinpoint weather forecast (Fig. 11).

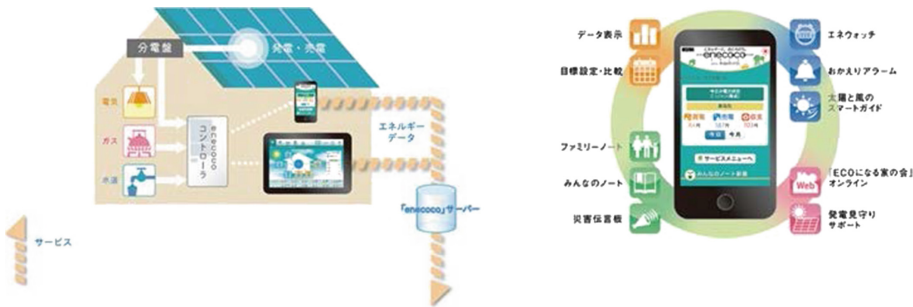


Fig. 9 Example of HEMS Service



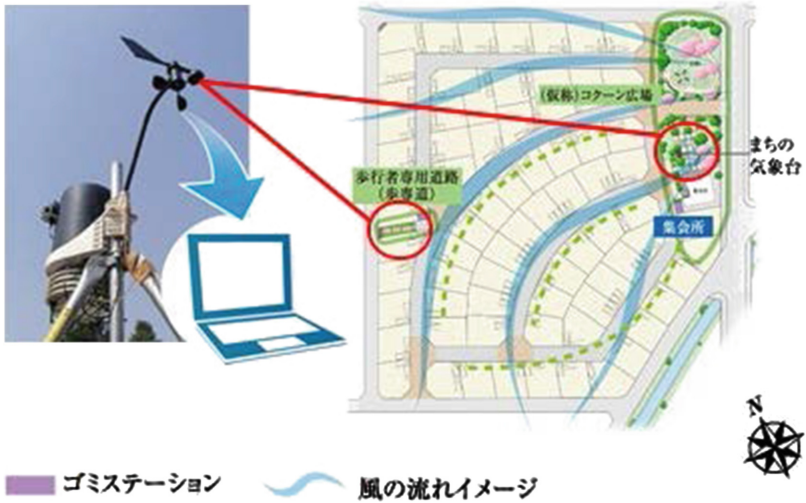


Fig. 10. Sensing for weather information

### まちのWEBサイト

今の情報と明日以降の天気予報を組み合わせ、生活に役立てることが出来ます。

#### まちの気象台の情報

リアルタイムの温度、湿度、降雨量、風速



#### 熊谷の天気予報

天気、最高・最低気温、湿度、降水確率



- まちの気象台の情報やアドバイスはまちの発電状況等とともに「まちのWebサイト」で見ることが出来ます。
- 雨など気象情報に合わせたアドバイスはメールでお知らせすることも出来ます。
- 一般的に、エネルギーの情報の見える化で約10%の省エネ(電力消費量の削減)効果があるとも言われています。

Fig. 11. The pinpoint information for weather in Kumagaya

## References

1. Tanizaki, J.: In Praise of Shadows. Vintage Classics, Poland (2001)
2. <http://www.330navi.com/kumagaya/community/index.html>