Incentive Guidance of Crowds by Smart City Lights

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Abstract

Although digital revolution has pervaded almost every part of daily life, cities remained seemingly analogue and furthermore inhabitants are mostly excluded from the digital layer. Considering the increasing wish for safety as well as present accident statistics, society faces the necessity to support the needs of their weakest traffic participants – pedestrians. As for today we propose to guide large crowds in an increasingly complex city by incentive hints. By using established infrastructure of city lights we try to ensure that our concept can be implemented in the most simple and realistic way. With this approach we expect to increase security and traffic optimization within open spaces by creating a more engaging way through the city.

1 Introduction

Over the past 5 years, the technology of street lighting has undergone a disruptive change. In 2010 discharge lamps have been nearly exclusively used as the standard street lamps. Today, in 2015, 90% of the replaced or newly installed lights, in street lighting, are generated by light-emitting diodes (LED). The new possibilities of semiconductor technology offer a broad variety of functions that are likely to find their way into public lighting. The lighting can be reprogrammed via the Internet, at the weekend it is brighter in the city centers than during the week or the lighting in the industrial area is brighter at shift changes. At stops, the light switches on as soon as a tram or bus arrives; walking and biking paths are illuminated more brightly when people use them. Energy costs can be determined and deducted for each lamp individually. The streetlight announces itself automatically as soon as it is broken or maintenance is necessary.

In terms of psychology there is a difference between the behavior of individual human beings and larger groups of people. This "crowd" is not only the sum of each individual behavior; in fact each crowd develops an inner form of dynamics that is rather difficult to determine and to describe. (Reicher 2001) Because of these difficulties it is not easy to guide an unorganized

crowd through a city's street network. To overcome this hazard we propose to use variations of luminous color to support guidance as well as to calm down crime scenes. A related approach, initiated by the city of Freiburg, that helps regulate noise by using indicating colors has been used on Augustinerplatz in Freiburg, Germany. A colored light located in a pillar sends visual signals based on the permitted acoustic level of the crowd to therefore call attention to the current noise level.[1]

2   Incentive Guiding

Facing the increasing amount of pedestrians in today's megacities like Tokio, New Delhi or Beijing, with more than 10.000.000 inhabitants, it is obvious that there is an inner need of not only "guidance" for the individual, but in addition to provide/guarantee an equally distributed use of space. Spreading pedestrians to different possible pathways through the city can only provide this goal. Because a blunt reference which route has to be taken (e.g. by an arrow pointing into the wanted direction) is very likely not widely accepted, we are seeking to find more reluctant methods. Relating to the different level of comfort provided by different color temperatures our first idea is to use light color to form incentives – subtle hints that motivate individuals to do specific actions (Russell 2006). Humans tend to rate light with lower color temperature (e.g. candlelight), at least in northern Europe, as more pleasant than light with a higher temperature (e.g. D50-lamp) (Baron et al. 1992). Light color influence the feeling of safety and well-being.[2] With these subtle changes in color for certain areas of a city's street network, our hope is that in average pedestrians prefer some roads and avoid other particular areas.

The color of the LED array can be adjusted through the whole color spectrum dynamically: With this ability it is possible to grade the lighting through different states (e.g. 1.800K for empty ways with a lot of free capacity, 3.600K for ways with medium free capacity and at last 5.000K for roads that are already overcrowded). By using a communication network between the lamps it is possible to "draw" ways with warm color temperature through the city network that might be preferred in comparison to the "blue" paths (see Figure 1).

The point of this incentive-setting-method is, that our lighting setup does not require attention and does not force the users by laws or orders to do something. Moreover every individual follows his own instincts subconsciously and is not prevented from his free will.

Furthermore not every participant has to follow the lamp's subtle advices to make this concept successful: In terms of crowd dynamics it is absolutely sufficient that a part of a group decides

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[1]   https://www.basicthinking.de/blog/2010/03/15/licht-aus-spot-an-desing-konzept-projiziert-botschaften-auf-den-asphalt (last visited 21.05.15)

[2]   http://www.hess.eu/de/Inspiration_Effizienz/Projektsuche/Projekt_BMBF__Freiburg_in_neuem_Licht/Flyer_Freiburg.pdf (last visited 8.07.15)

to change their method of path finding. With this strategy it could be possible to achieve a better load balancing in the overall street network.

Furthermore it is possible to highlight particular danger zones (e.g. construction sites, accidents) with special illumination. As a result the dangerous road is not used by uninvolved and the task forces are able to operate under the best lighting conditions.
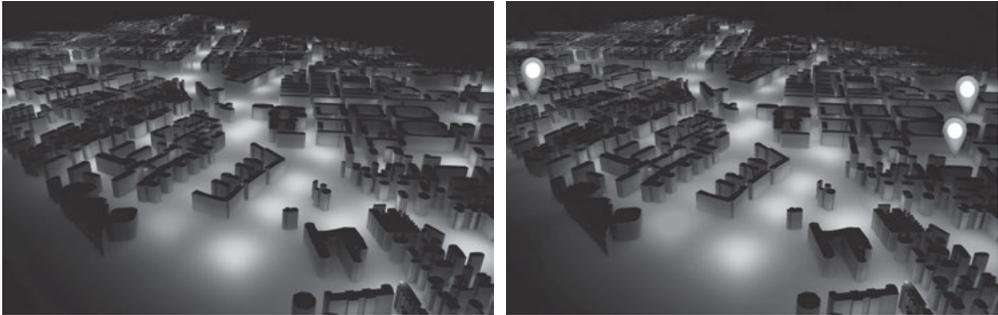

Figure 1: Highlighting different ways via color temperature (left image). Warmer color temperature at crime scene hotspots (right image). The three crime spots are marked with pins. Both images are exaggerated for a more obvious visualization

3   Calm Down Crime Scene

The second idea within this topic is the attempt to change people's behavior directly in order to suppress criminal tendencies in particular districts of a town. A study by Baron et al. (1992) indicates that the human brain shows different reactions on variations of a lighting's spectrum and wavelength. Ambient lighting can have direct influences on human alertness, heart rate, tension and on cognitive processes.

By use of the changing ability of the color temperature of our street lighting, color impression can be adapted dynamically to the different probabilities of criminal cases.

As illustrated in Figure 1 two hotspots are localized where the danger of criminal activity is significantly higher than in other regions of the city. In this areas the illumination is slightly modified in its color temperature:

It seems that ambient light in warm color temperature (e.g. "warm white": 3.000K) can result to a lower heart frequency and to stronger tendencies to resolve interpersonal conflicts through avoidance in comparison to "cool white" lights (about 4.200K) and D50 lights (5.000K). The use for calming down larger groups of people with tendency to conflict-seeking seems obvious.

The combination of incentive guiding and crime prevention is also thinkable: The warm color temperature is not only a stimulus in terms of avoiding conflicts, it also makes certain areas of the city a more pleasant place where more people tend to stay.

4   Validation & Evaluation

Due to the rather complex approach of this concept a quantitative analysis did not seem expedient. To evaluate the hypotheses, three standardized face-to-face interviews (16 questions in total) were held with experts from different specialist fields. The experts were:

- Prof. Paola Belloni, PHD, professor of lighttechnics & lightplanning
- graduate engineer (Dipl. Ing.) Steffen Köhler, distribution head of Philips Lighting in Baden (Germany)
- graduate engineer (Dipl. Ing.) Simon Sieß, architect and urban planner

A broad consensus emerged in terms of security: all experts share the opinion that variations of the street light in color and intensity can actually improve the security in urban areas.

Also the theory of the increasing requirement of guidance through the city's street network was shared in all conversations. Belloni pointed out that it is very likely that the concept of color temperature can offer this mentioned guidance through its subtle incentives. The usage of LED with the ability of changing the spectral distribution was rated as a very promising idea by Köhler as well as Sieß. By using the smart feature of light and power distribution through the whole network of street lighting system, the concept will allow significant energy savings – which also has been confirmed by all interviewed experts.

5   Next Steps

Considering the evaluation of our interviews, we are confident that our design can provide first steps into guiding people through future cities. To further evaluate in which exact way different lighting temperature guides people, we plan to simulate different settings and use cases within a 3D computer based application to provide constant lighting settings throughout the experiment. A conceivable approach could be to let people complete different tasks within a city. For example a task like "please find the next metro-station" could be used to evaluate which of the lighting situations are preferred by the respective study participant. Another promising possibility to validate our concept, might be a prototype of the above mentioned lighting system to deploy first field tests.

References

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