Interactive City Lighting

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Abstract
LED based lighting systems have enabled radically new possibilities in the field of artificial lighting. This is due to in part to the LED being digitally controllable which means this efficient light source can also be integrated with sensors and smart environments. This has opened up a new world of lighting and lighting interaction opportunities that has been applied in new concepts in many of the indoor lighting domains. The outdoor lighting domain however has focused mostly on the LED's efficiency and low cost of ownership to save energy and money for local governments. The use of the LED as a potential means for providing interactive city lighting for social good or entertainment is as yet a fairly unexplored area. This is therefore the focus of this workshop to bring together a community of researchers, designers and technologists to explore the potential of interactive city lighting and how it could support or enhance the lives of those living in a city.

Author Keywords
LED lighting; lighting control; city lighting; multi-user

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design; Human Factors

Introduction

The Light Emitting Diode (LED) has caused a profound change within the lighting industry. This is due in part to the LED's key properties of being digitally controllable, physically small, highly efficient, and cheap to manufacture. Each of these contributes to the attractiveness of the LED over the traditional light sources and consequently the LED is fast becoming the default choice. For outdoor lighting the LED is particularly beneficial for being highly energy efficient and simple to maintain due to its long lifespan. Furthermore, due to the variety of colors available from LED sources they have often been used for city beautification to illuminate buildings and places of public or national interest [12]. The digitally controllable aspect of the LED means it can be easily managed by software and digital interfaces [9]. Consequently, when used in conjunction with sensors and software programs the light output can be used as a response to people or situations; a key aspect that is worth exploring, especially in the context of city and public lighting for this has yet to be fully deployed or exploited. For example, the interactivity can optimize energy saving schemes where lights can be dimmed when no one is present. Similarly, interactivity can be used for making decorative lighting more dynamic and engaging by allowing people to control some aspects of their urban lighting [4,10,11].

In previous workshops on interactive lighting control [1,2] several projects that were focused on city lighting were presented. These few examples showed how a number of independent teams were beginning to realize the potential of using the LED and its attributes to the full in outdoor lighting.

Poulsen et al. [11] investigated how pedestrians' movements can be used for controlling the illumination of a town square. When people walked through the square the general lighting was dimmed slightly and a brighter circle of light would appear and then follow them as they walked. One of the key findings was that many people who crossed the square did not notice any change of illumination, while those who could see the square from a distance, such as from their apartment, clearly noticed the change in lighting, creating a notion of actors and observers. Another example is the work of Pihlajaniemi et al. [10] who created LightStories. Using the LightStories website, any visitor could create a dynamic lighting design to be presented along a pedestrian street for a whole hour.

Many cities will use light to illuminate architecture in urban prime locations. Boring et al [4] implemented a remote interaction system in conjunction with a media façade that enabled people to color a building by changing the light in each window using their smartphones.

One other direction that is being explored is to enrich lighting systems with sensor networks that will enable intelligent and autonomous lighting control, based on contextual or implicit user information [3]. An example of an experiment done by the Intelligent Lighting Institute at the TU/e is on perceived safety of dynamic road lighting which continuously adapts to the presence and behavior of pedestrians [7]. Work of this nature have a natural fit with urban environments that are highly dynamic and need to support a greater variety of activities from everyday commuting and shopping to festivals and promotions.

These examples of responsive urban lighting demonstrate different levels of interaction: implicit or presence based lighting [3,7,11]; indirect by creating a lighting scene that can later be reproduced by a lighting system [10]; and finally real-time explicit interaction [4]. However, while this work is interesting and commendable, there is a need for research into how people react and accept interactive city lighting and for what they may need it for. Initial work has been undertaken in this area on the acceptance of dynamic lighting solutions by various stakeholders [6], but a validated approach is lacking. Hence, the design of interactive systems in this domain is in need of a more coherent and systematic research effort to explore and understand the application of dynamic light in public spaces.

In previous workshops on the subject of interactive lighting systems, several topics were identified as being the core of this research area: semantics of light; light applications and technology; multi-user; and interaction paradigms. The conclusion was that with a greater understanding of these topic areas, others can apply interactive lighting more confidently to their particular applications. In this workshop we want to continue this exploration and promote research into this domain. In particular the focus will be on the different aspects of interactive urban lighting from the stakeholders' perspective e.g. government, pedestrians, business, residents, wildlife etc.

Goals of the Workshop

In the previous workshops [1,2] the domain of interactive lighting as a research area was outlined and our initial vision was formulated. This workshop focuses on the particular domain of urban lighting and how the public may interact with it. The goals of this workshop are:

1. *Identify key opportunities for new forms of interactive lighting systems in urban context.*

The urban environment is changing throughout the world and individual cities will have their own particular requirements; one size is unlikely to fit all in this case. Therefore, the global reach of this conference will help us bring together a diverse group of people who can share their insights from their own work and cities. This inspiration will help to stimulate ideas as to how different cities and communities may utilize interactive lighting. Differences and similarities between cities and people will be explored and recorded which can fuel new research topics.

2. *Explore interaction paradigms that can be (re-) used for interactive urban lighting.*

The CHI community has many years of experience in interactivity and applications of UI technology and this wealth of knowledge will be extremely useful in pushing this domain forward. Existing or new UI methods may be applicable to the urban context to assist with the needs and desires of the people that will be explored in the first part of this workshop.

3. *Examine adequate ways of prototyping and evaluating interactive lighting systems.*

The scale and complexity of many urban lighting systems makes the evaluation and prototyping of such systems challenging. In some cases virtual prototyping using systems such as a CAVE environment [8] can be used. In other situations small scale models of the environment can be created to preview the interaction

[13]; however, it is not clear which evaluation method is best for particular types of installation. Evaluation methods may be used to assess the light output and the acceptance of the wide range of users and stakeholders, such as residents, tourists, traffic specialists and police departments.

Other methods may also be required to assess the interaction of urban lighting systems since this domain may enable new forms of interfaces to be applied which in turn question how to build such systems from scratch [5]. Unlike interaction with a traditional GUIs for example, idioms and methods for urban/public UI are still evolving. Early prototyping of these systems is critical in order to get the design right and achieve a usable and enjoyable outcome.

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