Controlling Urban Lighting by Human Motion Patterns Results from a Full Scale Experiment

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ABSTRACT

This paper presents a full-scale experiment investigating the use of human motion intensities as input for interactive illumination of a town square in the city of Aalborg in Denmark. As illuminators sixteen 3.5 meter high RGB LED lamps were used. The activity on the square was monitored by three thermal cameras and analysed by computer vision software from which motion intensity maps and peoples trajectories were estimated and used as input to control the interactive illumination. The paper introduces a 2-layered interactive light strategy addressing ambient and effect illumination criteria totally four light scenarios were designed and tested. The result shows that in general people immersed in the street lighting did not notice that the light changed according to their presence or actions, but people watching from the edge of the square noticed the interaction between the illumination and the immersed persons. The experiment also demonstrated that interactive can give significant power savings. In the current experiment there was a difference of 92% between the most and less energy consuming light scenario.

Categories and Subject Descriptors

J.5 [**Arts and Humanities**]: Architecture; K.4.0 [**Computers and Society**]: General

General Terms

Human Factors, Experimentation, Design.

Keywords

Urban Light Design, Urban Lighting, Responsive Light Design, Interactive Illumination.

1. INTRODUCTION

For the first time in human history, more than half of the human population inhabits urban environments, and this now presents itself as second nature to humans. The urban context is of a very complex nature and is composed by a multitude of different networks, infrastructures and volumes. The city has become the dominant scenery for everyday life. As such it presents still greater design challenges for an improved urban spatial performance, which can adapt to changes and present inspiring, efficient and stimulating public spaces.

One must acknowledge that urban spaces are sites of movement and interaction that contain unused potential [15, 16]. If we can monitor and potentially understand how the urban space is used in terms of movement and occupancy patterns, we can generate site-specific maps that can be used to control elements in the environment such as the illumination,.

People will in this way interact direct or indirect with elements in the environments, thus establish an exchange also described as feedback in the world of computation. The study of feedback in computer systems, describing the relationship between sensor and acting environments, can be tracked back to Norbert Wieners [29] notion of cybernetics; a marriage of control theory, information science, and biology that seeks to explain the common principles of control and communication in both animals and machines [29]. Since then much work has been done in the field of computer human interaction. Research fields such as robotics [1], responsive environments [19], situated technologies [24] all contributes to a particular focus within the field of sensing and responding to change.

Inspired by the cybernetic notions from Gorden Pask [22] Usman Haque presents experiments that utilize sensor technologies and lighting as part of a larger collective constructed environment where people and objects collaboratively create social domains as in the case of Sky Ear and Open Burble [11]. In the two cases environmental feedback between weather systems (electromagnetic waves and local winds) and social actors are essential in the temporary composition of the color and the intensity of the light. Hence the balloons mediate a direct relation between subjects and weather phenomena, it establish a platform for conversations, between the humans, calling a balloon, causing waves of light to appear between the sky ear and the observers. On the level of the subject, internal conversations presents questions related to the level of engagement;

(a) Overview of the Kennedy square without the lamps, seen from the position of the thermal cameras.

(b) Kennedy square with the lamps at daytime. The main train station in the background.

Figure 1: Kennedy square in the city of Aalborg in Denmark.

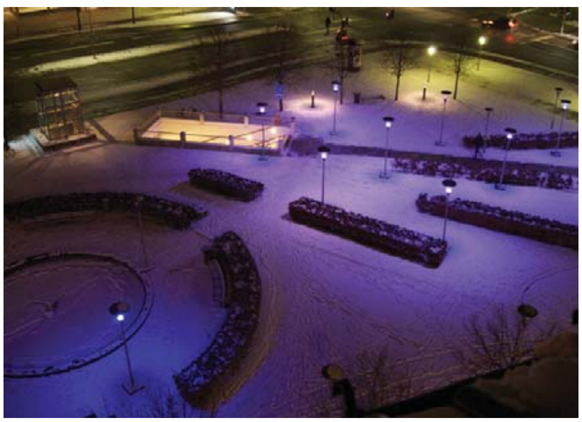


Figure 2: Overview of the Kennedy square with the 16 lamps, seen from the position of the thermal cameras.

to what level does I feel like participating? As performer, actor or just a passive observer enjoying the show? More external stimuli are constantly affecting our choices and engagement in the event, (weather, social norms, economy etc.) these internal and external conversations is a keystone in the understanding of systems and knowledge produced within them [21]. Another example is MY Studios Low Rez reactive sound poles [18], which is a spatial sequencer, allowing the by-passer to compose different sound-scapes. This installation has proven to be a mediator for vivid interactions between performers and observers of the event [25].

Within the contemporary art field Philipe Beesley [2] pushes the exploration of responsive environment inspired by reaction patterns in nature, exemplified in the art installations Endothelium and Hydrozoic. In these Beesley explore how he, inspired by nature, can design artificial life forms that produce life like behaviors and appearances, this artistic approach motivate a series of internal conversations; What is this? Is it a life? I am just a significant small part of the interaction pattern, but still I affect the ecology like behavior etc. Thus the installations are not build to be interactive toys but rather responsive environments, where relations and interdependencies are to be explored. In the project Dune [4] the artist Daan Roosegaarde brings a 60 meter long permanent reactive light and sound installation into the landscape along the Mass river in Rotterdam. The installation consists of thousands illuminating light straws that react in different behaviors. Similar to Beeslys the behavior of the lighting is inspired by natural mechanisms, hence it can be scared, excited, curios. Within the last decade these and many other art installations represent cases in the emergence of a new artistic expression in media, interactive and installation art that has proven a creative aesthetic, social and architectural potential for a design discipline concerned with feedback between humans and environments.

Within the industry of lighting, firms like Echelolon [5] and Philips [13] has entered the development of technologies for large-scale control systems of outdoor lighting. They contribute to the development of tools and techniques for new types of light designs, which open the window into the design of behaviors of the light. Within the larger urban perspective notions of the smart grid [6] also support this trend of a more efficient and intelligent energy use. This responsive paradigm is deeply related to the discipline of design.

This study will focus on the development, implementation and investigation of interactive urban lightings. It is motivated by the fact that in the coming years urban illumination will change from light sources based on mercury or similar technologies into Light Emitting Diodes (LED) or other less energy demanding light sources. Especially LED light sources is from a control point of view interesting as they will open for new ways to control the illumination, allowing designers and engineers to develope interactive light settings that for example dim or change color in real-time.

To fully release this potential it will be necessary to automatically monitor the activity in the urban environments. This task is very difficult and can be solved at various levels of detail. In the fully monitored situation a persons status of mind could be estimated, as being glad, sad, busy, relax etc. This is, however, at the moment not feasible with the current sensing technologies and models for human behavior at hand, which will require front views and high resolution images of the face [20, 17]. However, computer vision technologies has developed so it is now possible to track peoples trajectory in urban environments and in this context especially newer thermal imaging cameras has shown promising results [26]. In this study we will utilize recent results within thermal

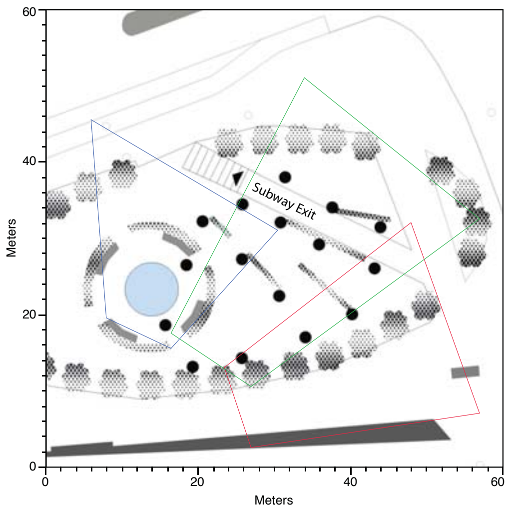


Figure 3: Overview map of Kennedy square with the areas covered by the three cameras.

computer vision combined with new LED lights for development of an interactive illumination setting where the ambition is to make the illumination provide safety, being energy effective, aesthetic appealing and potentially give the people another experience of the urban space.

During January these technologies were used in a full-scale experiment on a town square in the city of Aalborg in Denmark. Figure 1(a) shows an overview of the square seen from the position of the thermal cameras and figure 1(b) shows the interactive lamps at daytime. In figure 2 the light setup is shown at nighttime. The activity on the square was monitored using three thermal cameras mounted on a building facing the square. The trajectories of the pedestrians where estimated using computer vision analysis and used as input to control the light behavior in four different responsive light scenarios.

The finding of the study was that in general people immersed in the interactive light setting did not notice that the illumination was changing according to their motion despite the fact that in one of the scenarios the illumination was dimmed significantly in comparison to the normal illumination of the square. On the other hand people watching the square from the outside clearly noticed the interactive light setting and hence got a new experience and impression of the square.

The paper is organised as follows, first the experimental site and setup is presented followed by and introducing to the applied computer vision analysis and the interactive illumination design. The observations of the four different light scenarios are then presented and discussed and finally the findings are concluded.

2. MATERIAL AND METHODS

The experiment took place at Kennedy square in the city of Aalborg in Denmark. The square is located between the main train and bus station and the city center and serves primarily as a transit space between these two locations, see figure 1(a) To monitor the square three thermal cameras type Axis Q-1921-E, with a 19mm lens were mounted in the height of 15 meters at one of the buildings facing the square. The cameras covered the area from where an exit of a subway from the main train station is located to where people leave the square on their way to the city center, as illustrated in 3. Along this pathway the 16 RGB LED lamps were placed, figure 1.

The street lamp is composed of a 70 cm tall Riegens Ray light fixture, figure 4(a), a 3.5 meter tall light post and a 60x60 cm concrete tile as foundation. An LED module containing 18 1W LEDs, six in each color (RGB) was mounted in the bottom of the light fixture. The individual LEDs are mounted on the module in a two rings configuration, where the inner ring holds the 6 red LEDs and the outer ring holds 6 green LEDs interleaved with 6 blue LEDs, figure 4(b). The LED module is connected to a DMX module installed inside the lamp post. This module enables a 0-255 step brightness control of each led color as well as an unique address of each lamp.

(a) Profile of the lamp housing. (b) LED module.

Figure 4: The LED lamp head.

2.1 Qualitative assessment methodology

To evaluate the performance of the computer vision analysis and the control of the illumination a mobile phone application was used to display the activity at the square and the light setting of the lamps, figure 5. The application also gave the possibility to control the lamps. Using the application it was possible in real-time to evaluate if the computer vision analysis worked as expected and that the light scenarios gave the right response according to the position and velocity of people passing through the light setup.

2.2 Observations

During the experiment observations of body language, gestures and behavior of the occupants on the square were made. The observation methodology was based on ethnographic studies and fieldwork techniques as they are articulated by the sociologists such as Erving Goffman and Edward T. Hall [9, 10, 16] and utilized by architects such as Jan Gehl, William Whyte [28, 7]. By observing the interactions from the edge of the street we were able to describe "space routines" in the transit space [7] and evaluate if people where immersed in or affected by the different light scenarios.

2.3 Computer vision analysis

Detecting and tracking people is a large research area in computer vision, most approaches using normal visual cameras. But due to falling prices on thermal cameras new approaches using these sensors have been developed lately. Thermal cameras measure the amount of thermal radiation that lies in the long-wavelength infrared spectrum (8-15 μm). All objects with a temperature higher than the absolute zero emit thermal radiation. The intensity and dominating wavelength depends on the temperature.

Since thermal cameras do not measure visible light, they have a clear advantage over visual cameras in night conditions. Also with visual cameras it is illegal to film public places in Denmark, but since people can not be identified from thermal images, this is not an issue with thermal cameras. This is the primary reason to utilize thermal cameras in this work. Figure 6(a) shows an example of the input image from one of the camera views.

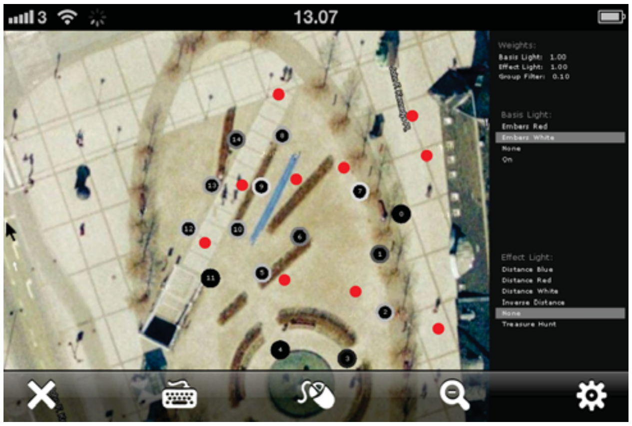


Figure 5: Snapshot of the iPhone application by which it was possible in real-time to see the result of the computer vision tracking and the resulting control of lamps. It was also possible to manually control the lamps by the application.

(a) Thermal image. (b) Binary image.

Figure 6: Example of the thermal input image and resulting binary image from one camera view.

As input to the illumination system real-time information about the position and velocity of people at the square should be found. The experiment is conducted in outdoor environment running continuously for a week. The temperature naturally changes, which gives a slowly changing background. Therefore it is chosen to perform a running average background subtraction as the first step in detecting people [23]. The background will be updated with selectivity, meaning that only if the pixel is segmented as background it will contribute to the new background:

$$B_{t+1}(x,y) = \begin{cases} \alpha F_t(x,y) + (1-\alpha)B_t(x,y) & \text{if } F_t(x,y) \text{ background} \\ B_t(x,y) & \text{if } F_t(x,y) \text{ foreground} \end{cases} \tag{1}$$

where B_t is the current background, F_t the current input image, α the learning rate and B_{t+1} the new background image.

As the experiments take place at an urban space with limited car access, it is assumed that all activity detected is human activity of interest. The difference image produced by background subtraction is binarised with a threshold value of 10. The resulting BLOB's with area of minimum 10 pixels are considered objects of interest.

The detected objects must be mapped to real world coordinates at the square in order to correspond to the lamps positions. The mapping is calculated using a homography matrix [3]. This matrix can be calculated using at least four corresponding points in image and world coordinates. Since the camera views are not aligned, a mapping must be calculated for each individual view. Figure 7 illustrates the mapping from image to world plane.

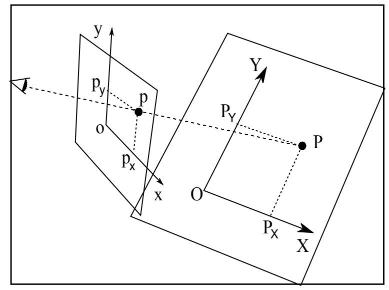


Figure 7: Example of the thermal input image from one camera view.

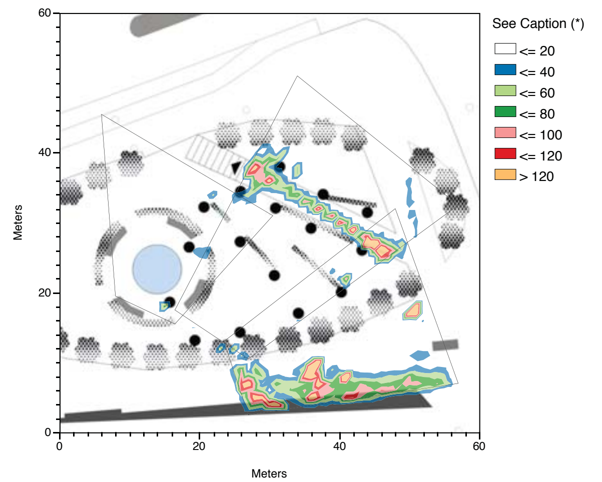


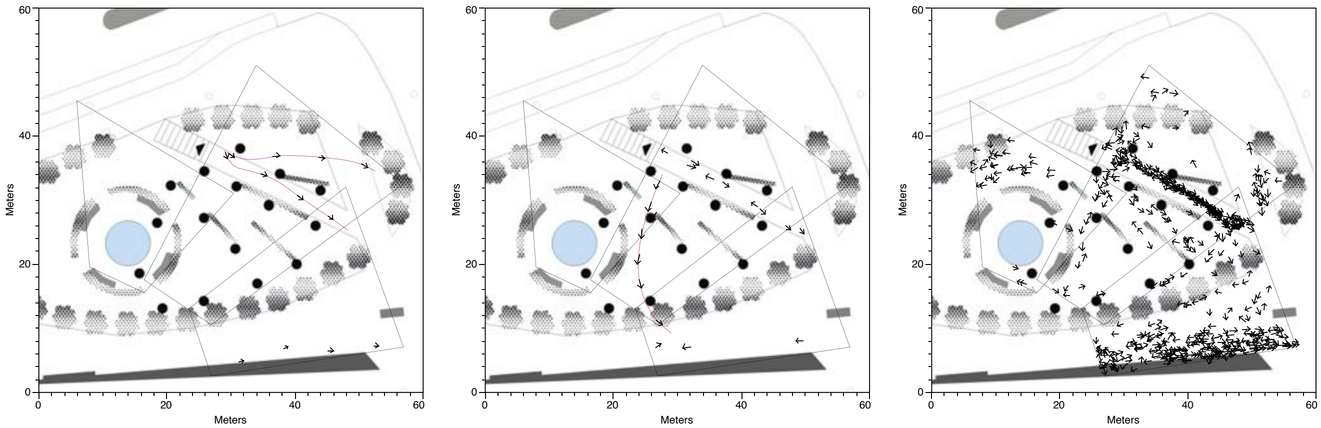
Figure 9: Occupancy map of the square counting number of observed persons in 1x1 meter cells sampled per 10 second.

For this purpose of illumination control from tracking data, groups of people should be considered as one object. The individual objects detected are grouped using single linkage clustering [12] with a distance threshold of 3 meters. This grouping also ensures that an imprecise segmentation, resulting in one person split in more BLOB's, or more persons found in one BLOB, does not change the result, as they will be treated as one group anyway.

In order to determine stable positions and velocity of the groups, a Kalman filter is applied to track the groups [27]. Splits and merging of groups are handled based on the distance between predictions of group tracks.

From the analysis it is now possible to estimate trajectories of persons on the square. Figure 8 shows the results of such trajectories in (a) for one minute, (b) two minutes, and in (c) the velocities vectors for persons walking on the square for a period of one hour. This information may also be illustrated by how the square is occupied, that is not taking the motion of the persons into account. Such an occupancy map with a resolution of 1x1 meter for 24 hour is illustrated in figure 9 sampled for every 10th second.

In this way it is possible to both get information about the instant motion of people on the square and accumulated motion over time. The first information may be used for instant control of the illumination whereas the later representation can be used for placement of lamps, that is the physical design of the illumination setup for a given urban environment, and to design basic illumination according to how the area is being used.



(a) One minute trajectories for two persons splitting up and leaving the subway.

(b) Two minute trajectories, with one person showing a distinct path towards the Bank located on the square.

(c) One hour velocity map of the activity that clearly demonstrates the used of the square. Especially, the use of the pathway from the subway to and from the main train station and the city center.

Figure 8: Estimated velocities vectors for people on the square.

2.4 Interactive illumination design

To approach a responsive light design of an urban square calls for a creative process similar to that needed in the development of architectural space. In addition, we need to develop tools to provide creative techniques where interactive scenarios can be sketched and evaluated in a creative and intuitive design process. To approach the design challenge, a physical 1:50 model of the square was developed. Simple white LEDs were used to represent the lamps, and, by using video input recorded on-site by the thermal cameras, we could test how different illumination designs would unfold on the square. In this way, we could simulate the light design using real-life video feeds and evaluate response times, rhythms and the placement of the lamps. When designing interactive illumination for a square, there are multiple factors affecting the formalized lighting, and the illumination becomes a result of many variables including security, social space, functionality, aesthetics, and energy. When these are merged together in a layered model, one can develop more or less interactive or playful light strategies, which still fulfill functional and aesthetic requirements.

2.5 Interactive lighting strategy

To ensure a persistent minimum illumination of the square when there were no occupants, we divided the illumination design into an ambient contribution and an effect contribution, which are later summarized into the final illumination.

2.5.1 Ambient Illumination

The ambient illumination is used to ensure that the square is illuminated when there are no occupants. We followed the hypothesis that a minimum of light is necessary to ensure that people feel that it is secure to enter the square. In the experiment, we worked with two ambient light scenarios:

1. A global minimum; all lamps are dimmed down equally to 10% of the full intensity.

2. Ember; the light slowly fades up and down between 0 to 20% in a random pattern.

2.5.2 Effect illumination

Effect illumination is the response that occur if an event takes place at the square. The event is detected by the computer vision analysis that in turn controls what light response to give according to the activity on the square. One can design a range of different complicated, banal or playful scenarios depending on the level of occupancy, velocity, climate, time of day etc. In this initial experiment, we tested the following two effects:

1. Light circle; as an illuminated aura around the occupants the localized light would secure an illuminated circle on min. 10 meter in diameter. This would allow the occupant to perceive variations in pavement and the face of people passing by, which in turn facilitate a secure navigation and travel over the square.

2. Light wave; As a playful illumination scenario we designed a treasure hunt scenario where two of the lights on the square indicate (blue light) the position of a trigger causing a wave of white light to travel over the square. After 10 seconds, a new blue light will emerge in another location. The hypothesis was to make a playful illumination that engaged people in playful and creative situations.

2.5.3 Final illumination

Summarizing the intensities from the ambient and effect illumination gives the light emitted from each lamp. If the sum of the two exceeds its maximum, the effect is truncated to 100%. The ambient illumination is active when no one is occupying the actual space. This, however, does not mean that the square is not experienced. Typically, it will be observed from a distance, a balcony, a living room, cafe etc. The illumination can then, with very low power consumption, make light patterns that are embracing, inspiring, scary, natural or just neutral depending on the design intentions. However, when people enter the space effect lighting strategies will secure a suitable illumination that potentially address security, aesthetics and social requirements.

3. EXPERIMENT

The experiment was conducted in the last week of January 2012 from late afternoon and into the early evening. At this time the sun set at 17.00 and thus collection of data and observations took place from 17.00 and until 20.00. The weather during this period was very cold by Danish standards, ranging from -5 to -10 degrees Celsius and very windy. Data was collected by observations and by logging of the results of the computer vision analysis. Between 100 to 150 persons passed the square each day in the observations period. The observations of them was done from the train and bus station and a bar facing the square. Each day 10 to 15 persons were interviewed.

4. RESULTS

During the experiment the experience and effect of the four different light scenarios were investigated. The normal illumination of the square was turned off during the experimental period. See appendix A for video examples.

4.1 Scenario 1, "Ambient Illumination"

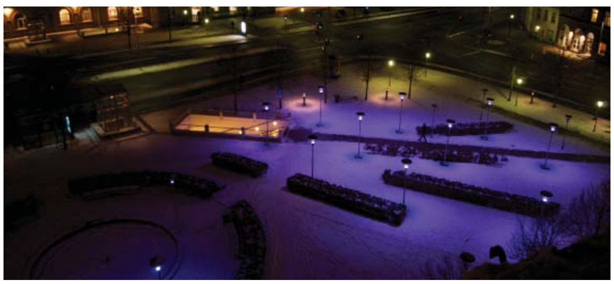


Figure 10: Illumination scenario 1 "Ambient Illumination"

The first scenario is a homogeneous illumination of the square. The 16 lamps had a static intensity of 80% white light and no effect was added. This light scenario was similar to, what could have been a traditional static illumination of the square, and was motivated by a need to compare the change of flow and social behavior on the square in different light scenarios.

It seemed that people did not see the changed illumination and acted like nothing was changed from the everyday life. When people were asked about the illumination only a few recognized the changed lighting, even though the lighting before were very limited.

4.2 Scenario 2, "Glowing Light"

The intention of the slowly fading white illumination was to make a lighting that would illuminate the square in an aperiodic way, leaving the square half lit but always in a process of fading down or up, this would give a feeling of overview of the square and support the feeling of security (figure 11). As a playful chance encounter a light wave effect was introduced.

A few people, realized the changing lighting and stopped to look at it, some looked like they thought the light fixtures were broken or out of order, one even asked if there was a loose connection and laughed. The majority of the by-passers did not seem to notice the change in the light intensity when they triggered the light wave; it was like the contrast between the slowly fading lamps in the ember scenario and the slowly moving wave was too small. Observed from a distance the slowly fading lamps had a calming, inspiring and lively expression, one should look very carefully to notice the wave.

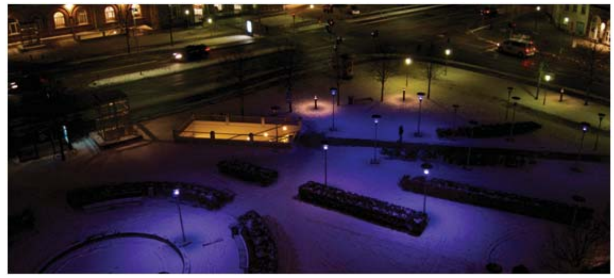


Figure 11: Illumination scenario 2 "Glowing Light"

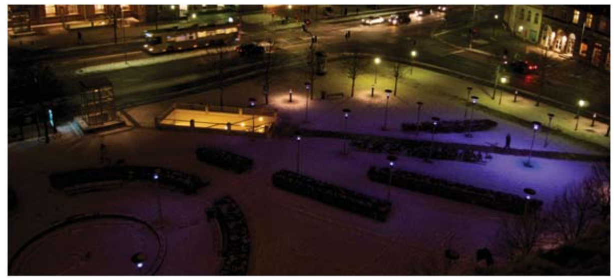


Figure 12: Illumination scenario 3 "White Aura". Notice how the light is following the person on the pathway.

4.3 Scenario 3, "White Aura"

Because of the relative big illuminated area around the people (10 meters) they did not seem to realize the darker square surrounding them. Observed from a distance one could se how people on the edge of the square were making pointing gestures towards the "performing" people moving over the square. The simple effect and the large contrast to the surrounding darkness made the pedestrian a natural focal point on the square.

4.4 Scenario 4, "Red Treasure Hunt"

The hypothesis of this scenario was to establish an unusual illumination, an illumination that made people stop up and confront the lighting in a playful manner. Figure 13 shows a sequence of images visualizing the effect scenario. 1 - A person is approaching the blue "trigger" light. 2 - The person triggered the effect which sends out a wave of light from the triggered lamp outwards. 3,4 - The light wave travels through the square. 5 - The light wave has ended and the trigger point is disabled for 10 seconds before it lights up a lamp again and a new person can trigger yet another light wave.

The few people who realized the changing illumination, did engage in the investigation of the lighting. When they realized that the illumination changed based on their presence, they began calling the lamp "it", which shows that they are giving the lamp a personality.

4.5 Energy consumption

In figure 14, the energy consumption for the different light scenarios is illustrated. The Ambient Illumination scenario as reference gave an energy consumption of approximately 230 Watt for the sixteen lamps. The other three scenarios are fluctuating in energy consumption due to the deliberate effects and the reactive effects according to the activity at the square. Clearly, the energy consumption of these scenarios are depending on the light design, and especially the choice of ambient light has a significant contribution of the mean value that the scenario fluctuate around. The

Figure 13: Illumination scenario 4 "Red Treasure Hunt" seen from the perspective of a person walking towards the subway entrance.

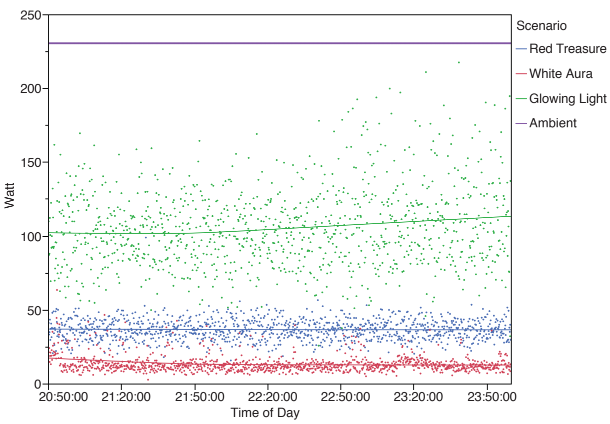


Figure 14: Energy consumption of the four illumination scenarios. The fluctuations around the mean it due to the light effect being set or not set according to the activity at the square and the effect of the changing ambient illumination.

order of the energy consumption for the scenarios were that the Glowing Light had a consumption of around 100 Watt and this was the scenario with the largest fluctuation that in some cases almost reached the Ambient Illumination level. In the design a lamp is chosen at random and then the light level is set to 10% of the maximum level from which it is then decreased. The Red Treasure Hunt had the second lowest energy consumption and was the scenario that fluctuated most due to the activity at the square whereas the White Aura had the overall lowest energy consumption about 20 Watt in average or 11.5% of the Ambient Illumination scenario. This is also the scenario that mainly depends on the activity at the square.

5. DISCUSSION AND FUTURE WORK

The flow maps of the 4 different light scenarios present no change in movement patterns; there is high intensity of movement on the paths in south and towards the subway, which correlate with the observations, done from the balcony. Hence, we can conclude that the reactive light patterns do not affect the overall movement and use of the square. People did not engage in, what we designed as "playful" and did not engage in the exploration of the reactive light system. This can be due to a less successful design, the fact that people mind their own business, because of the cold evening hours of the Danish winter climate or because of the evening time, that produced a dominate goal oriented behavior. The effect illuminations were directly triggered by the action of individuals, in the initial hypothesis we assumed that these effects would change the behavior of people and affect their way of seeing each other. In the observations of the life on the street, we did observe that people crossing the square, did not realize the changing lighting, but people observing from a distance could see how people "painted" light paths on the square or triggered a wave. The observer could be a person in a bus, on a balcony, in the waiting room for the cinema etc. For them the square became a stage setting where actors, whiteout being aware of it affected the lighting and was observed more carefully. This observation supports the concept of passive surveillance as presented by Jane Jacobs [14].

These observations leave the light designers with a new challenge: How can we design adaptive systems that change behavior due to changing situations and needs? In times of low occupancy a simple and functional reactive light strategy might be sufficient whereas in a warmer climate interactive playful scenarios might be applicable. Furthermore, at public events the street lighting might be used as an extension of the stage lighting. Extending the notion of centralized light control in to the world of smart phones, one can imagine a light system that knows your personal preferences for lighting and prepare the city or park with your favorite settings, as such it becomes an extension of your expression of mood, identity or just favorite color. These possibilities are subjects for future experiments. Furthermore the experiment underline the hypothesis that reactive and sensor based lighting systems will save energy and the amount of energy saved depends on the designed light scenarios. In the experiment we present an energy saving of 92%. However to access this resource new robust technologies need to be developed.

This contribution encourages a stronger link between studies in the contemporary interactive art scene and the behavior design of public lighting. The authors have not been able to find systematic research in the field of experienced social and aesthetic qualities of responsive light design in the "smart city" context. When we still have the centralized control unit for sketching light scenarios, a wide range of design drivers has the capacity to control the illumination and there are three main challenges in the future work: 1) to further develop design scenarios, and develop the ethnographical and qualitative evaluation techniques of such, 2) to face the technical challenge and build simple reactive and robust stand alone solutions, which perform sensing and acting behaviors, and 3) we suggest further development and explorations of the flow maps, which can inform us about usage of space instantly and over time and thermal comfort.

To approach these design challenges will call for interdisciplinary research, where engineers and architects will work together for development of new robust tools and novel design methods, to be tested in the 'laboratory of the street'. Favoring a design side of mediated lighting can cause inefficient light tools and favoring a technical side would risk to create normative and boring environments. Embarking in this interdisciplinary journey, we will search for skills to develop new tools and techniques to modulate a new creative environment.

6. CONCLUSION

Street lighting is build to illuminate the square extending the potential use of public space into the dark hours. Until now we have focused on the energy performance of the light bulb street lamp. Because of the recent development in the field of sensor and LED technologies we are now able to modulate the light to any given control paradigm. This study shows new possibilities and reflections for applying simple reactive light strategies, together with pragmatic reactive lighting models in the design of interactive urban lighting scenarios. It does this through four experiments using thermal cameras and computer analysis that allow designers to detect occupancy and flow patterns on the street. The data is utilized both as input to a real-time light control system and as a mapping of long-term occupancy and flow, allowing researchers and urban planners to access data on the use of urban spaces. In this paper, the evaluation of three interactive light strategies; Glowing Aura, Glowing Light & Red Treasure Hunt, reveal the possibility for reactive lighting to be applied in public spaces and present a significant energy saving up to 90% without people changing behavior.

This result shows that very dramatic changes are needed if light designers are to engage a person in transit. However people making light patterns as actors on a stage, underline the points of Presentation of Self in Everyday Life by Erving Goffman [8]. The majority of the visitors did not realize the changing of the light, the first time of their visit, but after observing other people perform from a distance their occupancy and flow patterns became a natural part of the architectural expression of the square.

7. ACKNOWLEDGMENTS

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APPENDIX

A. VIDEO

For video examples of the scenarios explored in the experiment please go to the following urls:

Glowing Light

http://vimeo.com/40589332

White Aura

http://vimeo.com/40653666

Red Treasure Hunt

http://vimeo.com/40589333