Implicit Interactions of Intelligent Lighting in a Retail Space

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Abstract
This position paper presents a lighting pilot of intelligent retail lighting. In the pilot, lighting was controlled in an implicit way according to the tracked movements of space users, following three lighting modes in dynamic and complex patterns. The demo was evaluated using a probe-inspired method, which revealed a large spectrum of different aspects of users' experiences. The paper discusses the preliminary findings of experiences concerning implicit interaction.

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intelligent lighting, adaptive lighting, implicit interaction, real-world pilot, retail lighting, experience

ACM Classification Keywords
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Introduction
Adaptive lighting system, which is intelligently controlled and reacts to movements of space users, can be seen as an example of implicit interaction. Schmidt (2000) has defined implicit human-computer interaction as "an action performed by the user that is not primarily aimed to interact with the computerized system but which such a system understands as input." [6] In a lighting context, this can mean e.g. a control where the system has capacity to analyze users' needs according to their behavior through a sensor system

SparkSpace project 2011 - 2014

Goal: to search for new possibilities to control lighting interactively by using intelligent real-time lighting control methods, multi-sensory measurements and user feedback.

Research partners:

VTT Technical Research Center of Finland

Oulu School of Architecture, University of Oulu

Research partners:

TEKES and a consortium of companies

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and can thus respond with functions and effects to the needs without any explicit effort or command. On the simplest level this means a motion detector which turns lights on when someone is entering the room. On the other hand, explicit interaction means conscious efforts in a certain level of abstraction to tell the system what to do. This can be done using a command line, a graphical user interface, a remote controller, gesture or speech etc. [6] Typically, in an indoor context this explicit interaction means a use of a control panel on the wall.

Intelligent lighting systems with controllable, networked luminaires and many kinds of sensor systems are gradually getting more familiar in commercial environments, thus having potential for both implicit and explicit interaction. So far, the motivation has mostly been gaining energy savings with the control of artificial light with presence or motion detection and daylight sensoring. However, the intelligent lighting control can also be designed to have an effect on the customers' shopping experience and behavior. Lighting can be used to create an attractive atmosphere in retail environment, thus creating an experience that can positively influence customers' mood and behavior [4]. By applying dynamic lighting settings and different lighting scenarios, retailers are able to provide changing visual stimuli to revitalize and increase customers' affect to the store [3]. Furthermore, dynamic changes in light provide a strong attention catching stimuli. Even peripheral cues of dynamic changes of light attract our interest and make us examine the reason for occurring changes [5].

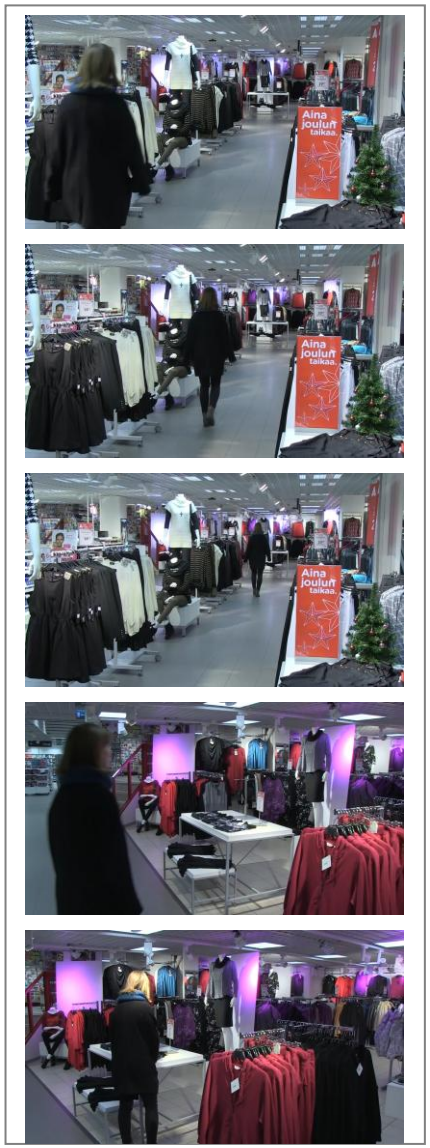
In this paper, we present a real-world pilot of implicitly interactive lighting system in a retail context. The lighting was designed to enhance the shopping experience, as well as to influence the customers' shopping behavior. The paper describes the main principles of the system and discusses some findings about shoppers' experiences of implicit interaction with light, based on the data from evaluation. On a more broad level, we reflect the benefits and limitations of the realized system using implicit control.

Intelligent Retail Lighting Pilot

The aim of the pilot was to design, develop and test a system of adaptive and intelligent lighting, which can attract customers to a certain store section and serve their visual needs while they browse the merchandise. In addition, light dynamics could be used to focus customers' attention to certain products, and to lengthen the time they spend in the store browsing the products. The pilot project had several development targets concerning the intelligent lighting control system, people tracking, as well as a design tool for adaptive lighting. In this way, the pilot setting provided us with a valuable opportunity to evaluate customers' experiences of intelligent lighting in a real-life retail environment, using technological solutions that are not yet commonplace. In this paper, the focus is on describing the main features of the system and design for implicit interaction, as well as reflecting the user experiences of interaction. A longer report of the evaluation results, as well as the system description will be published later, e.g. in [4].

Pilot Setting and Intelligent Lighting System

The research setting was a part of ladies' clothes section that was clearly separated from the surrounding space. The space had rather low ceiling height for a commercial space, only 2.4 m. To create visual,



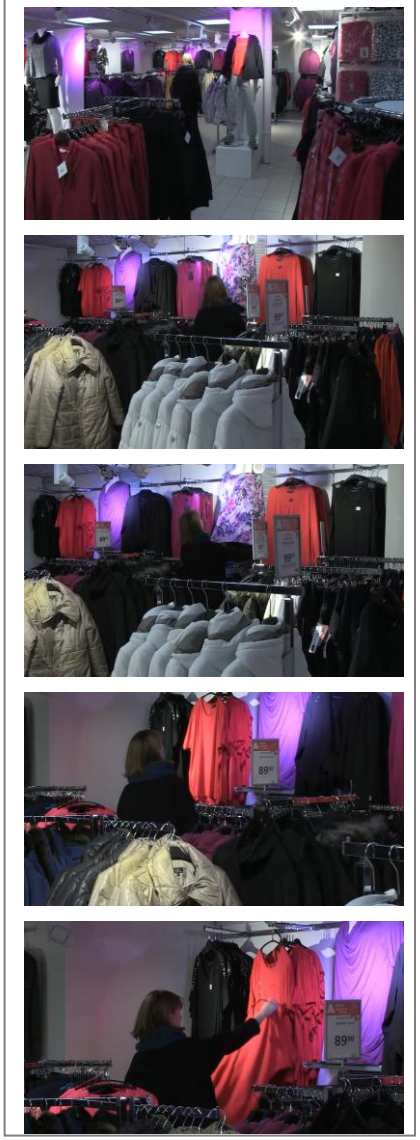
illuminated focal points to the area, five mannequin figures were placed there in front of white background boards. The lighting installation for the pilot consisted of controllable LED-luminaires (4000 K) for general lighting, and controllable LED-spotlights (3000 K) with RGB LED-spotlights for emphasizing mannequin figures, background boards and garments hanging from the racks. RGB-luminaires were used to produce both warm white light and colours. The intelligent control of adaptive lighting was based on tracking of the customers' positions and movements in the test area and its approach regions with networked depth camera sensors. The customers were classified to belong to a certain type due to their behavior (position and movement direction), which then resulted triggering of lighting adaptations.

The Design for Implicit Interactions

In order to gain knowledge of the effects of adaptive lighting on customers' experiences, three different lighting schemes were created. One scheme, **"Static White" (SW)**, was created to provide a point of comparison: a good, basic retail lighting situation. For dynamic and adaptive lighting schemes we created both a scheme containing only changes in light levels, **"Adaptive White" (AW)**, and a scheme containing light level and colour changes, **"Adaptive Colour" (AC)**. The design for the lighting adaptation for the two adaptive lighting schemes followed a three-mode strategy of responses to customers' movements in the pre-defined sections of the test area and its surroundings. The adaptation modes were "Attract", "Focus" and "Keep in the area". The **"Attract"** mode was intended to attract the attention of customers entering to the vicinity of the test area, in order to attract them to the area itself. Customers walking towards the test area triggered brightening of the spotlights and a lively rhythm of altering light levels on the back wall and on the background panels of mannequin figures. On AW days this light dynamics was done with only warm white light and on AC days with warm white and shades of red and magenta. When a customer stopped in front of the site, she triggered the **"Focus"** mode of adaptation. The design aim in this mode was to focus customers' attention to products in the front area of the test site, and to make her enter there for a closer look. Light colours followed the same logic as in "Attract" mode. Finally, when a customer entered the test site, **"Keep in the area"** mode was launched. In that mode, lighting was intended to serve the customer by increasing the illumination of the products near the customer to enhance their visibility. In addition, some garments further away from the customer were highlighted in order to make the customer notice them and continue further. In this mode, the light triggered by a person moving in the area, was of 3000 K tone also in the RGB spotlights, so that the customer could detect the clothes' colours naturally.

Evaluation

The test site was set up in October 2013 and taken down in February 2014, and the test ran during that time in three-day rotation of SW, AW and AC schemes. In order to evaluate visitors' experiences of the different lighting schemes, we used a probe-inspired method [2]. We refer here to the Cultural probes methodology introduced by Gaver, Dunne and Pacenti [1], which employs visually enticing and playful material to engage participants in reflection without direct researcher presence, and to self-report their thoughts. The study was conducted in five weeks in



October and November. Our participants (19 persons) were females (from 35 to 55 years). The evaluation probe consisted of a probe package with three custom-designed notebooks, and a preliminary, 30 minutes long semi-structured interview. The notebooks included relevant information concerning the assignment, a floor plan of the department store and the test area, and several open-ended questions that were meant to foster participants' reflection on their experiences. Each participant filled out three notebooks; one for each visit in the department store and the test site. On each occasion, a different lighting scenario was in operation.

Interaction Experiences

All the observers noticed the dynamic changes of light, and most of them found positive aspects in the behavior of light, such as attraction, positive attention, interesting product presentation, focusing on products, comfortable atmosphere and beautiful visual effects. However, it is interesting that not all observers did mention motion detection and some described the changes of light as random. Some of the participants mentioned wondering what the logic behind the lighting behavior was. Even though the implicit interaction should have been quite easily recognizable when walking inside the test area, reflection of the adaptation design helps to understood why some participants had difficulties understanding the logic of lighting behavior. The concept combined three modes so that a part of the dynamic changes of lighting resulting from a person's movements did not happen near her. In addition, the amount of customers in the area and its approach regions had an effect, as all of them caused lighting adaptations. This creates a mixture of logical but also seemingly illogical patterns in the dynamics of light. This depends also on what part of the space the observer is looking at. The multi-user aspect can be seen as a further design challenge.

Those observers who realized motion detection, found it interesting as an idea. They understood that it served their visual needs in browsing and showing them new things as they moved in the area. Thus implicit interaction was seen as relevant to their needs. However, detailed design of lighting adaptation patterns raised also some critical comments: in some positions the timing was late, and for some persons, the light levels changed too quickly. However, many of the visitors found the lighting dynamics also pleasant and restful.

To conclude, intelligent control of lighting in retail environment can enhance the customers' shopping experience in many ways, even when they do not experience having implicit control over the lighting and interacting with it. When the implicit control of lighting was noticed, the motion detection was seen as an interesting idea. We argue that adaptive lighting has promising potential for design concepts as it can attract, tempt and guide customers, facilitate their seeing and make their shopping more experientially rich. Implicit way of control and interaction seems to be suitable for retail environments, as the customers do not have to make any effort to control lighting and the lighting serves their needs in a natural and inherent way. However, the results show that a careful design of detailed aspects of adaptation patterns and light dynamics is very important in creating pleasant environments, as dynamic light is a powerful tool for future designers.

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