LumaFluid: a responsive environment to stimulate social interaction in public spaces

Gianluca Monaci[1], Tommaso Gritti[1], Martine van Beers[1], Ad Vermeulen[1],
Bram Nab[2], Inge Thomassen[2], Marigo Heijboer[2], Sandra Suijkerbuijk[2],
Wouter Walmink[3], and Maarten Hendriks[4]

[1] Philips Research - Eindhoven, The Netherlands
[2] Department of Industrial Engineering & Innovation Sciences
Eindhoven University of Technology, The Netherlands
[3] studio:ludens - Eindhoven, The Netherlands
[4] Little Mountain - Eindhoven, The Netherlands

Abstract. *LumaFluid* is an interactive environment that explores new ways to stimulate emotional and social engagement through light. A vision system localizes people present in the *LumaFluid* square. Colored spotlights highlight each person and connections are drawn between neighboring visitors to underline and stimulate interpersonal communication. Two versions of the concept where deployed during the 2011 STRP Festival. In this paper we describe the conception and realization of the installation, and we discuss the insights collected during the event.

1 Introduction

In large cities, people socialize in squares in open air at evening. *LumaFluid* is an interactive installation that explores ways to stimulate social interactivity between people in outdoor public spaces using light. The principal intents of the installation are twofold: first, we want to attract the attention of the visitors with a colorful and mysterious environment. Then, we want to explore ways to encourage the social interaction of the visitors through light.

Lately artists have proposed a growing number of interactive augmented reality (AR) installations, following the progress and accessibility of technologies [1,2]. Many AR installations involve the combination of light and video projections with the physical space [3,4,5,6]. The design of interaction modalities between passersby or visitors and AR installations is a crucial and relatively novel aspect, in particular in public, urban installations. Through interactivity, the audience becomes an active component of the installation, influencing the course of the events. In most of the above mentioned works [4,5,6], the environment is responsive to visitors' presence, but the response lies in the environment itself. Here, in the path of Snibbe's work [3], we focus on the emotional and social engagement of people, using space and light as means to stimulate interaction.

LumaFluid was installed at the 2011 STRP Festival[5], one of the largest art, music and technology festivals in Europe, with 31.000 visitors in 2011. During

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[5] www.strp.nl

Fig. 1. *Version 1* (left) and *version 2* (right) of *LumaFluid* at STRP festival.

the ten days of festival, two versions of the installation were run. The first version, in Figure 1 (left) focused on having fun together (emotional engagement). Vibrating light particles in shades of green fill the interactive floor. As soon as visitors enter the floor, they attract particles, forming large colored spotlights. Streams of particles appear between people when they move closer together, underlining the possibility of social interaction. When standing very close, the two spotlights morph together and start pulsating in response. The second version, in Figure 1 (right), was intended to have a more explicit connecting element (social engagement). Visitors on the floor are highlighted by a colored spotlight, but in contrast with version 1, the background is completely black. Like the previous version, a visual effect links neighboring visitors: here a line that morphs from one spotlight's color into the other. Through this mechanism, visitors can create colorful patterns which change continuously as people move, join and leave. In both versions, the idea is to use interactive light effects as a stimulus (or a pretext) for people to connect to others in a playful way. We observed and interviewed many of the visitors of the installation during STRP 2011. For a lively impression of *LumaFluid*, please check our video at `vimeo.com/34655968`.

2   Installation Setup

The *LumaFluid* installation at STRP is shown in Figure 2. A grayscale camera was installed over an area of 7m×7m at about 4m height, looking downwards (in a red square in the figure). The camera has a wide angle lens to capture the whole installation area and it is mainly sensitive to infrared (IR) radiation. IR illumination was provided by four IR LED light sources mounted at the corners of the area (highlighted by yellow boxes in Figure 2). In this way the camera can capture IR images of the square while filtering out illumination changes produced by the installation, as well as light coming from neighboring luminaires.

The captured images are analyzed by a computer vision software that, using a background subtraction method, localizes the visitors present in the installation area. Their positions are communicated to a rendering software that creates the output visuals. The images from the rendering software are split into nine images that are projected back on the scene by a grid of 3×3 video projectors (highlighted with white circles in Figure 2).
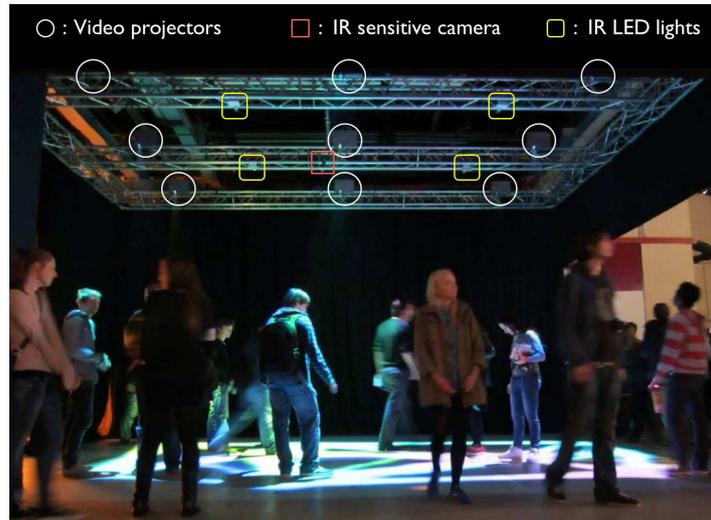
Fig. 2. Setup of *LumaFluid*. A camera (red square) senses the space and provides location information to the rendering software, which projects the graphics back using nine video projectors (white circles). IR LED light sources are highlighted in yellow.

3 Interactions and Impressions

During the first five days of the festival, version 1 of *LumaFluid* was used, while in the last five days version 2 was adopted. We observed the experiences of people who approached and used the two versions of *LumaFluid* and we collected interaction statistics by carrying out three type of observations. Firstly, we observed the installation as a whole 127 times (65 times in version 1 and 62 in version 2), for ten minutes, at regular intervals. Secondly, we analyzed the individual behavior of 199 people from the moment they came close to the installation until the time the exited it: 83 (42 male, 41 female) in version 1 and 116 (69 male, 47 female) in version 2. Finally, we carried out a structured interview with 104 visitors. We interviewed 56 visitors (23 male, 33 female) for version 1 and 48 people (26 male, 22 female) for version 2.

While we managed to keep a certain balance in the sample in terms of number and gender for the two versions, we have to underline that most festival's visitors were Dutch, and many with a background in design, technology or art. Another bias factor lies in the age distribution of the samples. The festival attracts mostly a young audience, but attendance was very heterogeneous across week days. Version 1 was mostly attended by adults in the age range 30-65, while version 2 was mostly visited by young adults between 18 and 30. Notwithstanding these limitations, we believe the collected data was from a sufficiently representative group of attendees, providing insights relevant for the analysis of the installation.

For both versions, we measured that around 80% of the people visiting *LumaFluid* entered the installation area. The concept of having a spotlight focused on them was generally appreciated by the public and many visitors were
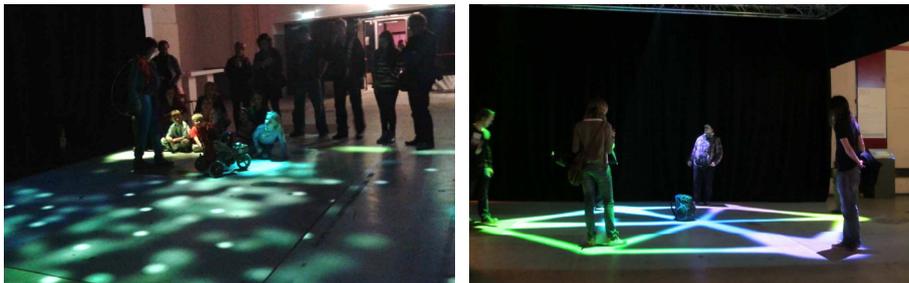
Fig. 3. (Left) Version 1 of *LumaFluid*: an artist using *LumaFluid* for her performance. (Right) Light patterns created with version 2 of *LumaFluid*.

surprised by the fact that the spotlight could follow them. One common reaction was to run or zig-zag, and then check if the spotlight was still following. Half of the visitors for version 1 and 40% for version 2 focused on the interactive floor while approaching the installation: in both versions, the floor was the main eye catcher. 36% of the visitors of version 1 and 16% of visitors in version 2 continued to look only at the floor even while inside the installation square. The fact that the participants' focus was on the floor seems to indicate the effectiveness of the visualization, although the main goal of the installation was to stimulate social interaction. However, *LumaFluid* does invoke interaction: 48% of visitors in version 1 and 52% of visitors of version 2 interacted with other persons. From the interviews, it emerged that not all visitors could understand the system's functionalities and its intent. Because of that, in a number of cases people left the interaction square after few seconds. Interestingly, we noticed that people also tried to interpret and attribute a meaning to aspects of the installation that were randomly set, such as the colors of the visualization.

The two versions of the installation had their own character and specificities. In version 1, the first thing we noticed was that people, mostly children, came up with different games to play, using the installation as a tool to create a gameplay. Most children seemed to enjoy themselves when playing their own fictional games using *LumaFluid*. A performing artist used the floor as additional attribute during her performances (Figure 3 (left)). This seemed to have a positive influence on how visitors perceived the performance: many more visitors stayed to watch the performance when the artist used *LumaFluid* than when she did not. Visitors explored what version 1 of the installation could do, for example by walking away or dancing. This however lead people to pay more attention to the installation itself, rather than to other people on the floor. Besides, half of the people indicated they did not understand that interaction with other persons was possible, often because it was not visible to them, or because nobody else was present at the floor.

Concerning version 2, because the visualization was much simpler, people understood the concept of playing together better: visitors created figures and patterns together, as in Figure 3 (right). To create these visuals, people looked at and talked to each other. Where the first version provoked an active, more

individual and game-like behavior, the second stimulated a more social and co-creating behavior. People also acted in way that were not anticipated by the authors. Some were seen lying down on the floor, others used objects like a backpack as part of their interaction (Figure 3 (right)). In the interviews, more people reported to find version 2 fun and exciting, although this version did require the presence of other people to remain interesting. Opinions were divided as to whether this type of visualization would lead to actual conversations, or whether it would remain restricted to shallow interaction such as smiling.

When comparing the two versions, we found out that version 1 is more interesting to visit and play with, also when someone is alone, whereas version 2 is only interesting when multiple people are present on the floor. People entering version 1 of *LumaFluid* seemed to understand the interaction possibility intended by the authors only in 14% of the cases. People entering version 2 seemed to understand this in 53% of the cases. However, for both versions about half of the visitors engage in interactions with others. Interestingly, it is not necessary to understand the possibility of interacting to actually start an interaction. In version 1 only 48% of all the interactions involved verbal contact, while in version 2, 83% of interactions involved verbal communication. The difference becomes bigger if we focus on the contact with strangers. In version 1 only a quarter of the people that had contact with strangers had verbal contact. In version 2 this figure raises to over three quarters: people who used version 2 had more direct contact with others, as expressed by verbal communication. This indicates that we are dealing here with two very different types of interaction. Observing the arousal states of the visitors, we noticed that version 1 elicited a more active behavior than version 2. The arousal level of people entering and interacting with version 1 was higher than for version 2. Besides, it was reported that version 1 was perceived to give more creative freedom to visitors. On the other hand, version 2 had a clearer concept, that was easier to grasp for most participants and that stimulated a more direct communication. There is an interesting tension between a fascinating concept, but difficult to understand (version 1) versus a clear concept, but with a limited creative freedom (version 2).

4   Discussion

One of the most important insight about the installation is the importance of both the aesthetic and functional components to keep the experience interesting and meaningful for the visitors. In future concepts we will investigate ways to merge the poetic elements of the visualization in version 1 with the clear links between visitors in version 2 to create meaningful and attractive interactive experiences in the public spaces.

In the interviews, several users indicated that adding an extra dimension would greatly increase the time the system would remain interesting. This extra dimension could be obtained by projecting the visualization also on walls, or adding sound effects that respond to the activities on the installation floor. Adding another dimension would not only enrich the experience of *LumaFluid*,

but it could also solve the current issue of visitors mainly focusing on the floor. While one group of people stated that the present interactive structure would lead to conversations with strangers, others thought it would only lead to superficial interaction (e.g. smiling) and suggested that more triggers besides light would be needed to evoke more interaction. More research is required to investigate how light, graphics and other modalities, such as sound, can enrich and stimulate interactions in different public environments.

Besides using the concept in public places such as squares or large halls, the observations drawn in this paper and the future developments of this work can contribute to applications such as theatrical or dance performances, as was done by one of the artists at STRP. During the interviews, participants repeatedly mentioned two settings where they think a system like *LumaFluid* would be interesting: playgrounds for children and nightclubs for adults. These two ideas were mentioned independently of the version used at STRP festival. These are two interesting directions to be considered in future instances of *LumaFluid*.

5   Conclusions

In this paper we described *LumaFluid*, an interactive installation that investigates new ways to stimulate social interaction in public spaces through light. The installation consisted of a responsive space where people are localized on near-IR images captured by a camera hanging on the ceiling. A rendering software projects light effects over the people present on the floor, highlighting and connecting them. Two versions of LumaFluid were deployed during ten days at 2011 STRP festival. By analyzing the behavior of hundreds of participants with the two versions, we concluded that few elements seem to be essential for an installation to stimulate social interaction: firstly, the lighting effects should be capable of grabbing the attention of visitors, to lure them in the installation area. At the same time, the initial effects should be intuitive enough for a person to understand the interactions he or she is having with the environment. To ensure that participation is sustained in time, gradually more sophisticated effects could be introduced. With regards to the social interaction, a similar incremental strategy could be used. This could also stimulate verbal interaction, as the more experienced participants could guide newly arriving people.

References

1. Grau, O.: Virtual Art: From Illusion to Immersion. The MIT Press (2003)
2. Bimber, O., Raskar, R.: Spatial augmented reality: merging real and virtual worlds. A K Peters, Ltd. (2005)
3. Snibbe, Scott: Boundary functions (1998) `http://www.snibbe.com/projects/interactive/boundaryfunctions`.
4. Levin, G., Collaborators: Motion traces `http://www.flong.com/projects/a1`.
5. Utterback, C.: Projects `camilleutterback.com/projects`.
6. Gritti, T., Monaci, G., Vignoli, F., Walmink, W., Hendriks, M.: Flower power. In: Proceedings of ACM Multimedia. (2011)