Low Resolution Displays for Performative Interaction in Public Spaces

Julie R. Williamson, Daniel Boland, John Williamson, Rod Murray-Smith, and Stephen Brewster
Glasgow Interactive Systems Group
School of Computing Science
University of Glasgow
Glasgow, G11 5DZ, UK
Julie.Williamson@glasgow.ac.uk, daniel@dcs.gla.ac.uk,
JohnH.Williamson@glasgow.ac.uk, Roderick.Murray-Smith@glasgow.ac.uk,
Stephen.Brewster@glasgow.ac.uk

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Abstract
When interactive systems require users to "perform" in front of others, the experience of interacting dramatically changes. This "performative" dynamic can be purposefully exploited in the design and evaluation of interactive systems to create compelling experiences. In our work, we explore these issues using highly flexible low-resolution displays composed of strips of individually addressable LED lights called Pixel Strips. These low-resolution displays can take a wide variety of forms and can be deployed in many different settings. We pair these displays with depth sensors to add playful interactivity, whole body interaction, and proxemic interaction. Such a combination of flexible output and depth-based input can be used for a variety of playful and creative interfaces. In this paper, we describe some of the most promising directions made possible using this technology, such as ambient interfaces that create playful reactive experiences, visualize pedestrian traffic, and highlight social dynamics.

Author Keywords
Performative Interaction, Interaction in Public, Low Resolution Displays.

ACM Classification Keywords
H.5.2. Information interfaces and presentation: Input devices and strategies.

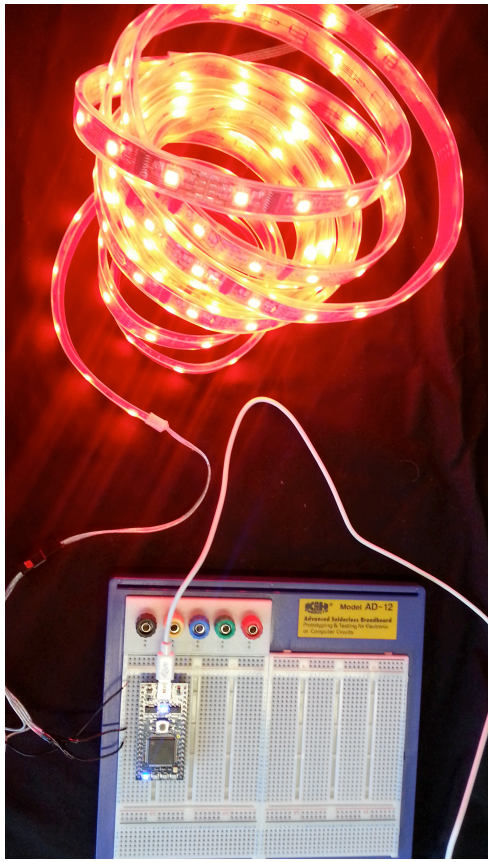

Figure 1. Individually addressable LED strips with mbed microcontroller.

Introduction

Interaction in public places is an opportunity for users to express themselves and contribute to shared experiences in social settings. These exciting extensions to user experience in public have led to the creation of a huge variety of performative interfaces, such as the WaveWindow interface [7], the Worlds of Information large public display [6], and the Bridge project that allowed users to `walk on water' [3]. The technologies that support public interaction vary widely, from large public displays, proxemic and whole body interaction using depth and motion sensors, and large tangible interfaces. This position paper presents one approach to developing compelling interactions using arrays of individually addressable LED strips and depth cameras.

Pixel strips, as shown in Figure 1, are flexible strips of individually addressable LED lights that are controlled using a microcontroller. We add interactivity to these strips using a Kinect sensor to capture movement and proximity from users near to the pixel strip installation. This technology supports rapid prototyping and flexible installation, encouraging divergent designs and exploration of novel interactions. In this position paper, we describe some of the performative dynamics we seek to explore with this technology and some of the directions we are currently pursuing.

Interaction in Public

When interactive systems require users to "perform" in front of others, spectators that may be watching and users' perceptions of their own performances influence the experience of interacting. During interaction in public places, users will be constantly evaluating the feedback from spectators changing their behaviour based on spectators' reactions [5]. The experience of interacting in front of others can have a significant impact of the perceived enjoyment, acceptability, and usefulness of interactive systems. These issues are especially pronounced in systems that specifically exploit the presence of spectators, encourage extravagant interactions, and build experiences that purposefully put users in centre stage. Designers of such *performative* interfaces must consider how the visibility of the manipulations and the resulting effects work together to create an experience in public places [9].

There is a strong body of previous work that builds on sociological and anthropological foundations to explore the issues of performance and experience as part of an interface. This previous work varies in its theoretical foundations, the primary focus of inquiry, and the methodologies used when evaluating performative interactions in different settings. Our approach revolves around the dramaturgical metaphors of Goffman, where any action in a public space can be considered a performance of some kind [5]. This approach to "everyday performance" considers how we present ourselves to others in daily life, how our actions are like performances of our desired 'character,' or the impression we hope to create, and how we are constantly adjusting that performance as we gather feedback from others.

There is a wide variety of research that focuses on both spectators and performers through qualitative or ethnographic evaluations. Sheridan *et al.* describe how performance frames can be used to understand participation in digital live art performances [8]. That research revolves around the concept of "wittingness," where individuals' awareness of the performance frame influences how they participate in a performative experience. Gardair *et al.* looked at how performative spac-

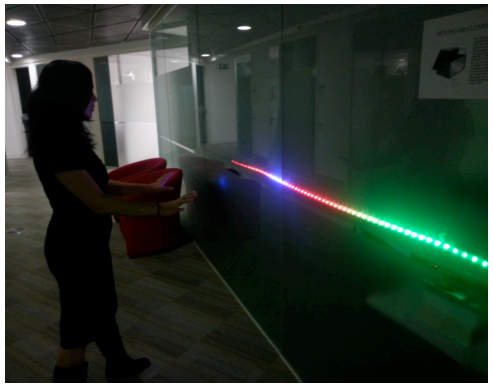

Figure 2. User explores a reactive playful prototype composed of a single LED strip.

es are defined for street performers, examining how passers-by transition into audience members in this setting [4]. Benford *et al.* also discuss the fluid relationship between audience members, witting or otherwise, and bystanders through a mobile performative game [1]. This project sought specifically to blur the boundaries of digital and physical aspects of the game to encourage performative activities in public places and implicate passers-by as unwitting participants.

Based on these previous works, we aim to explore the following key issues with our pixel strip installations.

- How can we capture and make use of unwitting performances?
- How do users discover and negotiate "interactive" versus "spectating" spaces?
- How can we create installations that support both performers and spectators?

Pixel Strips for Performative Interaction

Arrays of LED lights can create compelling interactive installations. Sato *et al.* used LEDs as pixels in a large-scale display at an airport departure lounge [10]. This installation, called "Constellation of Departure," displayed the night sky above with visualizations of departing airplanes. Chandler *et al.* also explored the use of LED lights for "emergent displays" where LEDs were used to create displays of self-organising pixels with a flexible shape and density [2]. Such LED installations provide a high level of flexibility and creativity with often beautiful and high impact results.

We are currently working on rapid prototyping and exploring interactive possibilities of such low-resolution displays with proxemics and whole body interaction. Our low-resolution LED displays are made up of flexible strips of individually addressable LED lights, as shown in Figure 1. The LEDs are controlled using an mbed microcontroller. These flexible strips can be deployed in a variety of ways, such as creating grids of LED elements, bending and wrapping LED strips around large surfaces, or suspending 3D shapes in open spaces. We add interactivity to these displays using a Kinect for movement and proximity input.

Interaction with Low Resolution Displays

We are currently exploring several directions of research using these pixel strip installations that exploit different aspects of performative interaction and interaction in public. By combining flexible displays with whole body interaction, we aim to design action that can be subtle or extravagant, allows spectators to fluidly between different roles, and encourages interaction between users and plays with social structures. A basic one strip installation is shown in Figure 2.

Reactive Playful Interfaces

The pixel strips can be used to create basic interfaces that are reactive to movement in real-time with simple and playful interaction. In this setting, users can explore interactive boundaries and discover interactive elements in the installation simply by being present.

- React to position in front of display and distance away from display
- Encourage exploration of simple visualisations that respond immediately to presence
- Allow multiple users to explore the same functionalities together

Visualising Pedestrian Traffic

Where the previous interface provides reactive and "in the moment" interaction, we are also working on prototypes that provide a temporal experience and visualise traffic in front of the display over time. Through this installation we aim to gather unwitting performances and capture the curiosity of spectators.

- Visualise traffic in front of the display as glowing trails which fade over time
- Support both interaction by creating trails and spectating by watching trails
- Make passers-by aware of the lasting impression of their own traffic

Highlighting Social Dynamics

By employing proxemic interaction, low-resolution displays can also visualise social dynamics and encourage users to interact with each other. More sophisticated visualisations could reward collaborative actions and create visualisations from observable social dynamics.

- Create visualisations the only respond to interaction between users
- Create visualisations that respond to collective group action
- Create visualisations that single out users in a group

Conclusions

Pixel strips provide a powerful and creative platform for exploring performative interaction in public spaces. In our research, we are currently looking at how we can use low resolution LED displays to create simple and playful installations, capture unwitting performances, and support interaction around social dynamics.

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