InterÉlastique

A system for control of an audio-visual experience using novel stretchable sensors

Paul Nemirovsky
Interactive Cinema Group, MIT Media Lab
E15-432, 20 Ames Street
+1 617 258 8948
pauln@media.mit.edu

Dan Overholt
Hyperinstruments Group, MIT Media Lab
E15-492, 20 Ames Street
+1 617 253 9306
dano@media.mit.edu

ABSTRACT
Interactive installations today typically limit the interaction by allowing only one active user at a time, and are commonly based on traditional forms of user input (i.e., keyboards, trackballs, touchscreens, etc.). This paper describes InterÉlastique, a system we have created that allows collaborative tangible interactions through a set of innovative stretchy sensors called eRopes[1].

The system represents an exploration of the relationship between music, text/poetry, visual elements, and physical space. Users are presented with two projection screens that are "connected" with six eRopes. By pulling these eRopes, the users change the music as well as the relationship between the text on each of the screens. Multiple users can collaborate, modifying poetry and music interdependently based on the combination of the different eRope's signals.

The system is composed of the eRopes and their related electronics, several MIDI synthesizers, two projectors, and a computer running the InterÉlastique application which provides audio-visual feedback to the participants.

Keywords
Music, video, emotional feedback, poetry, eRope, interactive installation, stretchable sensors, collaboration.

INTRODUCTION
Our goal is to make interactive art installations more easily accessible to the general public and children. As such, we hope to influence the user of the future to be much more proactive and creative in their interactions with art and technology. By using the eRope as our interface, we can give the public a method of participating in an innovative installation without feeling overwhelmed or intimidated by technology.

Most installations today are based on trigger-mode sensors (such as buttons and other event-based inputs), whereas InterÉlastique utilizes the tension and elasticity of the eRope to provide users with continuous control and feedback. The user input is mapped to the audio-visual components of the installation according to our predefined rules:

1. The aesthetic forms should change gradually and smoothly from one state to another.

2. The users' expressions should be directly mapped to an audio-visual effect to reflect their transformations.

3. Input from multiple users can be combined to produce predictable emotional/informative system responses.

RELATED WORK
The last 20 years have been marked by an explosion of interactive installations, in both the musical and visual domains. We were particularly inspired by a few of them: Chris Janney has created what he calls "an urban musical instrument" in a subway station in New York [1]. While waiting for a train, commuters can reach above their heads and break beams of light to trigger music. Tod Machover worked on the Brain Opera [2], exploring a variety of multiuser-oriented interaction techniques. George K. Shortess in his "Doorways of Meaning" (1996) explored the boundary between inner and outer experience by allowing viewers to generate voices using colored cord networks. Finally, the Shape of Sound exhibition series [3] was aimed at creating dynamic environments with the audience defining its relationship to the art at any given moment.

MOTIVATION
The InterÉlastique system is aimed at creating an environment of play. Visitors can use the eRopes as an intuitive interface to control the installation. In order to construct this environment, we began by defining our model of interaction. We chose to work in the domains of music, visuals, and poetry, and defined the system's responses for a variety of situations (e.g., idle state vs. single eRope vs. several active at the same time).

In order to encourage users to be active participants in the installation, we attempted to provide evocative content by designing an unusual combination of visuals and dynamic textual elements, as well as composing a set of emotive musical patterns. We then conducted user tests in order to refine the system's content. A brief overview of the Design & Testing process follows.

INTERACTION DESIGN & TESTING
The InterÉlastique system provides real-time response to the users, maintaining the perception of action-reaction for both participants and observers. The goal of InterÉlastique is not only to provide users with an innovative mode of control, but also to encourage collaborative use of the installation. For example, a group of users pulling several eRopes

---

[1] eRopes (Patent Pending) are electronically active tensile sensors. We have developed this technology in cooperation with Saul Griffith, using a novel technique wherein conductive fibers are braided around a bungee cord in order to determine the amount of tension applied to it.

simultaneously can achieve more complex textual and musical transformations than is possible with only one user.

In an effort to develop a new way of interacting with textual and musical elements, we mapped the system's audio-visual output to the following emotions (observed using time-domain classifications of the signals from the eRopes): Anger, Joy, Sorrow, and Surprise.

Anger is mapped to strong, irregular movements of the eRopes with large amplitude swings over time. Joy is recognized as a smooth, continuous movement of the eRopes with a rising speed of modulation. Sorrow is expressed by slow continuous changes in tension with an overall decline in modulation speed. Finally, surprise is mapped to the collaborative interaction such that, soon after one of the eRopes is triggered, several others follow suit.

All of these parameters affect the audio-visual elements presented to the visitors. These are: triggering of various textual and musical elements from pre-composed libraries, speed and direction of the text movement on the screens, color and intensity of the visuals, text sizes, controlling audio levels and filters, etc. The interactions were partially pre-scripted, but the interaction manner was left completely up to the users, dependent on the way they chose to control the eRopes.
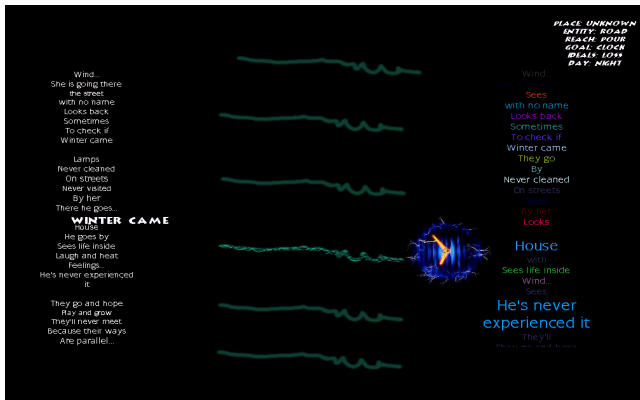

Figure 1: InterÉlastique software

The InterÉlastique software (fig. 1) has been designed using the Lingo programming language, with additional Visual C++ modules for serial port access, MIDI file playback, and visual effects.

TESTING / EVALUATION OF RESULTS

The InterÉlastique system was installed in the central atrium of the MIT Media Lab (a place frequented by many people), providing us with much informal feedback. In order to gather more formal data, a group of 24 users (4 sessions each with 6 users) was asked to interact with the system, creating new collaborative musical / visual experiences. We asked the users whether the system was responding to their actions in a way they considered natural and engaging. Users reported that their feeling was heavily affected by the actions of the other users, verifying that we had met our goal of achieving interdependency between users' inputs.

We did not observe a significant difference in interaction between users that were given an explanation of the system before they tried it, and those that we asked to figure it out by themselves. The system facilitated interaction – users that

were given an explanation first tended to be more proactive, asking others to join them in the creative process. Users have also reported that they enjoyed the process of learning as an integral part of their experience (rather than as an annoying first step). Additionally, the data seems to show that users tend to synchronize their interactions with the system after a short period of adjusting to each other.

STRUCTURE OF INTERÉLASTIQUE

The InterÉlastique hardware (fig. 2) is based on the eRope technology we have been developing here at the MIT Media Lab. The prototype eRope electronics system uses a custom-built circuit board that has a Microchip PIC microcontroller (with a built-in analog-to-digital converter), as well as analog signal conditioning electronics.
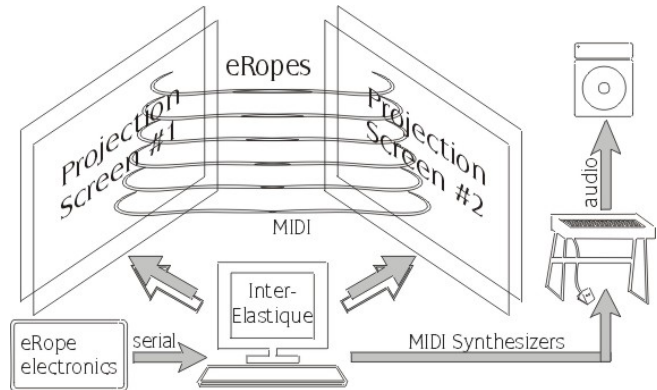

Figure 2: InterÉlastique hardware

The microcontroller runs a custom operating system which does data acquisition for each of the eRopes, and provides serial RS-232 communication to the main computer. The tension in each of the eRopes is converted into an 8-bit value and sent to the main computer, which is running the InterÉlastique system. This computer controls several MIDI synthesizers which produce the music, as well as two video projectors which display the poetry and visuals.

FUTURE WORK

We are working on making a distributed model of the InterÉlastique system with multiple clients running simultaneously via a network. This will allow remote control of the installations, and open the way to redefining collaborative participation in an art installation setting.

We hope to expand the scope of our work by defining more generic modes of interaction based on non-discrete interfaces, with the ultimate goal of allowing each user to become an artist. We hope that this will serve a variety of artistic and educational purposes, and help blend the distinction between the passive audience model and the proactive model of artistic communication.

REFERENCES

1. Janney, C. – "REACH - New York", 1996

2. Machover, T. Hyperinstruments: A Progress Report. Cambridge: MIT – Media Lab, 1992.

3. The Shape of Sound, http://www.lonestar.texas.net/~monorecs/bos/sos.html

4. Roads, C. – "The Computer Music Tutorial", MIT Press, 1998.