ProjecString: Turning an Everyday String Curtain into an Interactive Projection Display

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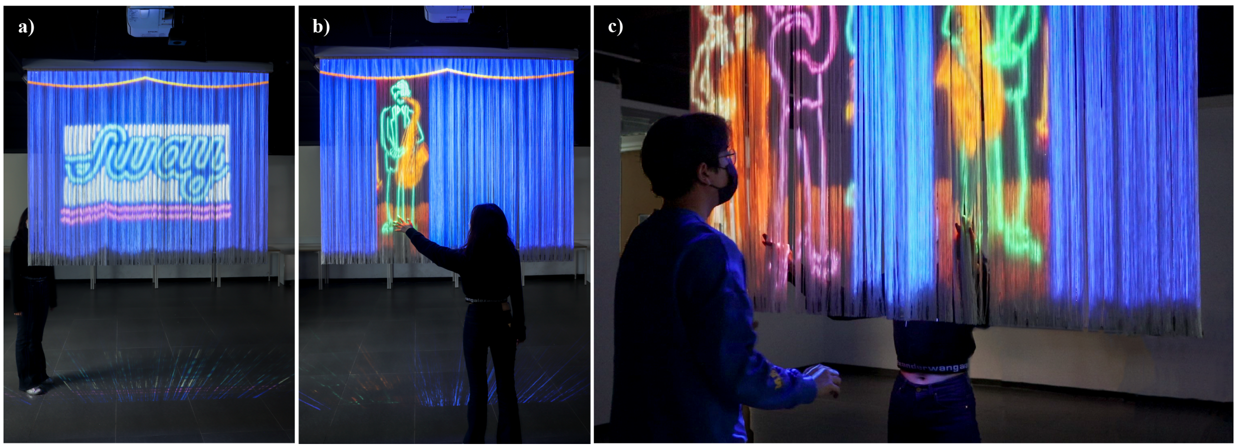

Figure 1: a) Front view of ProjecString, b) Touch-sensitive interaction, c) Multi-user, dual-side interaction

ABSTRACT

We present ProjecString, a touch-sensitive string curtain projection display that encourages novel interactions via touching, grasping, and seeing and walking through the display. We embed capacitive-sensing conductive chains into an everyday string curtain, turning it into both a space divider and an interactive display. This novel take on transforming an everyday object into an interactive projection surface with a unique translucent property creates novel interactions that are both immersive and isolating.

CCS CONCEPTS

• **Human-centered computing** → **Interaction devices**; • **Computing methodologies** → **Mixed / augmented reality**; • **Hardware** → *Displays and imagers*; • **Information systems** → *Multimedia content creation.*

KEYWORDS

Interactive projection display, Touch-sensitive curtain, Capacitive sensing, String curtain

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SIGGRAPH '22 Posters, August 07-11, 2022, Vancouver, BC, Canada

ACM ISBN 978-1-4503-9361-4/22/08.
https://doi.org/10.1145/3532719.3543203

ACM Reference Format:
Wooje Chang, Yeeun Shin, Yeon Soo Kim, and Woohun Lee. 2022. ProjecString: Turning an Everyday String Curtain into an Interactive Projection Display. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Posters (SIGGRAPH '22 Posters), August 07-11, 2022.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3532719.3543203

1 INTRODUCTION

Projection displays are ubiquitous in everyday life, used for showing movies at a corner of a bar or dividing spaces in an art exhibit. However, they serve a passive role in providing entertainment or information, limiting the engagement with the audience to a one-way communication. In order to increase interactivity with the space dividing, media displaying surfaces, we present ProjecString, an interactive projection display made by incorporating touch-sensitive chains into an everyday string curtain.

The idea of non-conventional projection display is a rather familiar concept, primarily taking two forms: flexible yet unbreakable interactive surfaces and mist-like, yet untouchable displays. The former type of projects [everyware 2011a,b; Sherwood and Allison 2012] use synthetic-fiber-based fabrics as projection surfaces that react in response to touch and deformation. While these enable interactivity, it limits the types of interaction to simply hand-based haptic feedback and to a single side of the projected surface. The latter type of projects [Lam et al. 2015; Rakkolainen et al. 2005] use mist-like particle-based material as projection medium, enabling 360-degree views of the media and movement through the projection. These projects, however, do not provide haptic feedback important in providing clear interaction feedback, limiting the interactivity.

ProjecString captures both the interactivity and the range of interactions by using string curtain as the projection medium and conductive chains as touch-sensitive sensor. People can touch and grasp the curtain, physically interacting with the projected media. They can also reach or walk through the curtain, encouraging simultaneous multi-user interactions from both sides with the projection and each other. Also, the translucent property of the strings enables users to see the projection from both sides of the curtain.

2 SYSTEM DESIGN

In order to create an interactive system that can both divide spaces while encouraging the occupants for an interactive content, we devised ProjecString that measures 180cm of width by 140cm of height. The touch-sensitive curtain hangs from the ceiling 130cm off from the floor at the chest height, providing enough surface area to fully divide a space while inviting users to touch and interact with it and its projected contents.

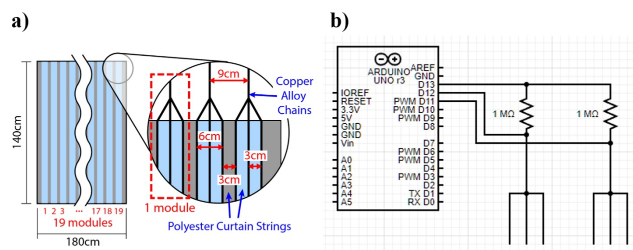

Figure 2: a) Geometric layout of the string curtain, b) Simple schematic of the capacitive sensing chains

The curtain is composed of three main materials: polyester curtain strings, copper-alloy chains, and zinc-galvanized weights. Nineteen input modules are embedded evenly among the fabric threads, consistently detecting users' touch (Figure 2a). Each module consists of three chains placed 3cm away from each other—roughly half the width of a small hand—to ensure user's touch is always detected. We used chains over more conventional conductive threads since the chains are of similar color, texture and weight as the curtain strings, ensuring seamless aesthetics and haptic congruence. The chains have 3/8th oz weights at the bottom that ensures that the chains return to position while providing constant downward force for more consistent electrical connection. The chains, combined with the weights, are the same length as the threads and reach the same height. The chains and the curtain strings are sandwiched between two strips of MDF, which is then hung from the ceiling. We employ capacitive sensing method using the conductive chains, connecting the chains to an Arduino Mega 2560 (Figure 2b). By sending out pulses at a constant interval from the output pins and detecting for any delay ins in the input pins, the curtain is able to detect touches; when a person touches the conductive chain embedded in the curtain, the capacitive interference creates a signal delay. The Arduino sends out readings of each module via serial cable to the main PC (1 for touch, 0 for none), providing real-time feedback on any input occurred. The delay time threshold for determining whether a touch has occurred is pre-set before running the program. A Unity program running on the main PC receives those data and projects appropriate scenarios onto the curtain.

3 APPLICATION: PUBLIC INSTALLATION

3.1 Interaction

We created an interactive jazz band scenario, in which the audience reveals a jazz quintet playing behind a closed curtain. Initially, a looped soundtrack is played quietly in the background. Then, when a person touches the curtain, a portion of the curtain disappears, revealing a musician playing a specific instrument. The revealed musician's instrument is also amplified, providing both visual and audio feedback to the touch.

We observed an open audience interacting with the curtain in a media art exhibit, confirming four different ways of interaction. Initially, the audience tentatively touched the strings to see what kind of responses occurred. Once they realized that any type of touch elicited a response (i.e. putting their hands through, or touching with other body parts like their faces), the interactions became more unique. Some started grasping the curtain in their hands, sometimes twisting parts of the display. Others took advantage of the the free and independent movements of each string, running their hands across the width of the curtain for a unique experience of swaying projection. The curtain also made the space division optional, with many choosing to walk through to explore both the other side of the projection and the exhibit. Others who did not walk through could still catch glimpses of the other side through the spaces between strings. People on opposite sides of the curtain would sometimes work together, either stabilizing the curtain by applying force from both sides or creating harmonies by selecting different musicians.

3.2 Evaluation

Post-exhibit interview revealed that the novel types of interaction encouraged the audience to interact with the projected media more, increasing engagement and joy attained from the interactions. Some noted that they were encouraged to interact with the curtain in more creative ways after seeing others trying out "goofy" interactions such as poking heads through. One participant noted that the experience felt more 3D than simple interactive projections on the wall, since they could walk around and engage with the projection from any direction. The flexibility and the strength in drawing people's attention makes ProjecString suitable for public installation purposes, dividing spaces without restricting people's movement.

While ProjecString received a generally positive feedback, some reported that sometimes touches would not be recognized immediately; due to the capacitive design of the chain sensors, the sensitivity would drop for people with dry hands. Future work could implement a threshold adjustment system adapting to the environmental conditions to better accommodate different skin conditions.

REFERENCES

everyware. 2011a. Cloud pink. http://everyware.kr/home/cloud-pink/
everyware. 2011b. soak. http://everyware.kr/home/soak/
Miu-Ling Lam, Yaozhun Huang, and Bin Chen. 2015. Interactive volumetric fog display. In *SIGGRAPH Asia 2015 Emerging Technologies.* 1–2.
Ismo Rakkolainen, Stephen DiVerdi, Alex Olwal, Nicola Candussi, Tobias Hüllerer, Markku Laitinen, Mika Piirto, and Karri Palovuori. 2005. The interactive fogscreen. In *ACM SIGGRAPH 2005 Emerging technologies.* 8–es.
Christopher Sherwood and Mike Allison. 2012. Firewall. https://www.aaron-sherwood.com/works/firewall/