FurPlay: Interactive Physical Fur Display with Bidirectional Input and Output with Graphics and Sound

Hyein Lee
Industrial Design
KAIST
Daejeon Korea
hyein.l@kaist.ac.kr

Chanwook Kim
Industrial Design
KAIST
Daejeon Korea
chanwookkim@kaist.ac.kr

Figure 1: Three ways to input graphics on FurPlay: a) hand drawing, b) user's voice, and c) preset on servomotors.

ABSTRACT

FurPlay is a new type of interactive physical display that uses fur as a medium and interacts with the user through graphic and sound. FurPlay is designed as a stand-up conveyor belt at eye level to induce the user's natural touch. The apparent softness of fur attracts the user's action and stimulate tactile sensation. User's touch or 30 servo motors controlled by the user's voice generates the graphic by raising the fur fiber. Then, The webcam reads the graphics and produces sound. The user can experience the two-way interaction through the conversion between the graphic and sound.

KEYWORDS

Fur Display, Physical Interaction

1   Introduction

From 2D liquid crystal displays to VR and holographic lenses, high-tech digital displays that convey information is overflowing. Digital displays, such as LCDs, have the advantage of being capable of delivering a variety of information through millions of pixels, but they do not give enjoyable tactile feedback. For improvement, Graffiti fur [1] used carpets as display that can be easily seen around us, and PomPom mirror [2] made a display combining two colors of fur. These works used fur as material; however, they just focused on drawing graphics, not on physical interaction. FurPlay is the touchable display that can give tactile feedback and visual feedback with properties of fur: softness and shading by flattened or raised fibers. Moreover, not only for the interaction made by the properties of fur, the graphic on the display are translated to sound, and the sound of user results to the graphic on display by the controlled motion of 30 servomotors.

2   Hardware

2.1   Aluminum Bone Structure

The standing conveyor belt is built with 40 mm by 40 mm aluminum profile with 176 cm height and 90 cm width. The height of fur display is 50 cm. These settings were designed to give an optimal environment for the user to input graphics with eye-level and enough size. At the top of the aluminum structure, where the conveyor belt is installed, two divided

profiles, left and right, are connected with long nuts to make the profile width adjustable about 4cm. This design was for belt tension by tuning the width of the profile after the belt installation on the gear.

2.2 Gear and Belt with Supporting Guide

We designed the gear and belt system to implement a standing conveyor belt. The acrylic and transparent rubber plate were laser-cutted to make the gear and the belt. The OHP film was attached to the outer surface of the belt so that the fur can be attached on the surface by preventing protrusion of the gears toward the belts and the fur fabric. The gear belt is mounted on top and bottom of aluminum profile structure. The conveyor belt was completed by attaching a microfiber cloth to the OHP film of the upper and lower belt. The direction of microfiber cloth was set in the opposite direction of servomotor motion to be scratched when the conveyor belt was running.

Figure 2: Gears and Belts with Supporting Guide

2.3 Drawing System

Drawing system was designed with 30 servo motors that were installed close to the fur conveyor belt to generate graphics from the sound recognition.
Thirty servomotors were arranged in a row, and legs were installed to each motor to scrape the fur. Servomotors were controlled using *Adafruit 16-Channel 12-bit PWM/Servo Driver* and *Arduino Uno*.

Figure 3: Arrangement of 30 servomotors designed to generate 30 compact lines.

2.4 Reset System

A reset mechanism for flattening the fibers was needed in conveyor belt system to avoid graphics overlapped as the belt rotates.
Initially, we simply tried sweeping through an acrylic roller that rotated rapidly in the fiber's growth direction. However, the display showed thinly remained scratched pattern. To solve this problem, an acrylic guide was installed before the roller to scrape the entire fiber once, so that no marks of a certain shape are left. The reset roller was controlled by a DC motor.

Figure 4:Reset system with roller and guide(left), and reset roller(right)

3 Interactions

FurPlay provides two-way interaction with the user. We wanted the fur display not only being consumed for touch input but also creating communication with the user. So we

implemented a bidirectional interaction where the graphics resulted from user's touch make the sound, and the sound from the user draw the graphics on display.

3.1 Graphic to Sound

First, the user touches the FurPlay at the eye-level height where the user can easily approach. Since the conveyor belt is moving, the touch and moving legs of servomotors raise the fibers and the graphics result. In real time, the graphics are taken via the webcam installed on an aluminum profile. The photographed image is used to read the vertical position of the graphics on the display through the OpenCV library of Processing. From top to bottom of FurPlay, 30 sections, which accords with the lines generated by 30 servomotors, were divided for the position reading. As the position perceived, matching piano sound comes out. The piano sound produces from a low degree (C3) at the lowest position of the conveyor belt, and to a 30-degree high wave (F5) at the highest position. The piano sound is used from the sound provided by the University of Iowa [3].

3.2 Sound to Graphic

The sound entered through the user's voice is converted into a graphic. FurPlay analyzes the sound input through the Airpot microphone installed near the servo motor through the FFT analyzer in Processing. The analyzed frequency is drawn as the dot or line depends on the length of voice by moving the servo motor at the matched position where the piano sounds at the same frequency. If the user makes a sound corresponding to a certain note, the servomotor will draw the graphic in the position corresponding to the note. Then this graphic will be recognized by the webcam again and converted to the piano sound with the same note.

3.3 Graphic Drawing

After implementing sound to generate the graphics, we've explored how users can do a richer interaction with drawing

system in FurPlay. Since the graphic made by the sound showed musical note, we wanted to deliver more descriptive information. Therefore we explored the possibility by trying simple text output such as "Hi" through the servomotor system.

4 Future Works

FurPlay showed bidirectional physical interaction with graphics and sound using properties of fur. Users can enjoy multiway interactions with FurPlay. For further study, we expect various matching sound and advanced human voice filtering would make interaction more fun. Moreover, since we added the graphics drawing system at the last stage of development, currently, FurPlay displays the preset text only. However, if this system could print out the recognized the voice in text or related image, we expect the user would understand more intuitively how the sound to graphics interaction processed and create richer interaction with FurPlay.

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