Clothesline as a Metaphor for a Musical Interface

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ABSTRACT
In this paper, we discuss the use of the clothesline as a metaphor for designing a musical interface called Airer Choir. This interactive installation is based on the function of an ordinary object that is not a traditional instrument, and hanging articles of clothing is literally the gesture to use the interface. Based on this metaphor, a musical interface with high transparency was designed. Using the metaphor, we explored the possibilities for recognizing of input gestures and creating sonic events by mapping data to sound. Thus, four different types of Airer Choir were developed. By classifying the interfaces, we concluded that various musical expressions are possible by using the same metaphor.

Keywords
musical interface, metaphor, clothesline installation

1. INTRODUCTION
Airer Choir is an interactive "clothesline" installation in which the metaphoric action of hanging clothes on a clothesline or clothes airer is recognized as creating sonic events. Thus, people can participate in musical performance by hanging "clothes". The aim of the installation is to determine the potential of an ordinary everyday action to represent, with the help of digital technology, an artistic idea.

There have been many works in which sonic events are created by specific objects, but the latter have been limited by their attachment of markers or electronic circuits. For example, in exhale[6], the clothes are made of conductive fabric used for interaction with the users. In Flock[4], audience can participate in the work by wearing the hat attached with a white LED. However, Airer Choir is a unique interactive installation because the clothing of anyone can be a medium for participation in the work.

This work is developed as a part of the Simple and Easy-to-use Musical Interface (SEMI) project. The SEMI project aims to design musical interfaces which provide easy-to-use control, facilitate multimedia performance, and offer enjoyable experiences for diverse audiences[5].

Based on the clothesline metaphor, four different types of musical interface that were developed for the performances and exhibitions are introduced. We propose how the mappings were applied differently in the four different versions.

2. CLOTHESLINE INTERFACE
2.1 Interface based on an ordinary object
The musical interface as "clothesline" was designed to convert one of our daily tasks into a musical expression. Thus, an ordinary object was modified for musical expression.

Many musical interfaces were based on ordinary objects. In particular, some interfaces focused on a ball metaphor because the ball is simple but familiar in virtually all cultures and various gestures can be used to control the interfaces. For example, in BRBI[10], rotation, spin, shake, and throw gestures can be measured. In Twinkball[9], MIDI notes are generated based on the gestures of grasping, shaking, and approaching the light. In another case, a virtual ball object is used for bouncing and passing by performers who have smartphones[3].

Tanaka[7] argued that these types of musical interface have forms independent from existing musical instruments, but they also can be designed as a model of an instrument. The four different types of Airer Choir also have this characteristic. They recognize the clothes hanging on the clothesline and sonic events are generated based on processed information about the clothes.

2.2 Clothesline as a metaphor
By an analogy with a familiar object in HCI, a metaphor is a guide to learning how to use an unfamiliar object[1]. Thus, various musical interfaces have been designed based on metaphors. Similarly, this work is also based on the hypothesis that a metaphor is a strategy to make interfaces more intuitive.

Compared with other common objects such as a ball, the clothesline metaphor induces users to play with the interface naturally. On the other hand, audiences have a problem playing with a ball-shaped interface without any instructions. They do not know they can grasp, shake, or even throw it because the ball was not designed originally as an object for musical expression and there are various existing gestures for using a ball. However, the clothesline metaphor limits the gesture to hanging clothes only.

In interface design, expressivity depends on transparency, which in this context means how the output of a device from an action corresponds with the expectation of both performer and audience[1]. For performers, the transparency depends on two facts: cognitive understanding and proficiency. Use of the clothesline metaphor is highly appreciated for the two facts. In terms of cognitive understanding, when considering a clothesline as a musical interface, anyone can easily understand that the action of hanging clothes is converted into a musical expression. In terms of proficiency, most people can enjoy the interface because hanging clothes is a very common action.

3. INTERFACE DESIGN

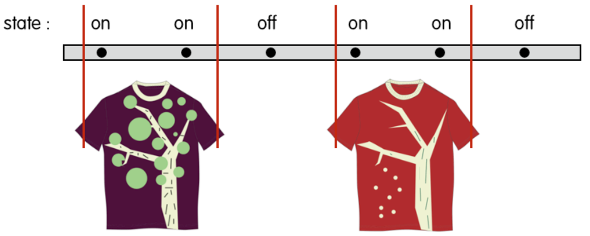

Figure 1: Several points store the data on the hanging clothes (discrete case)

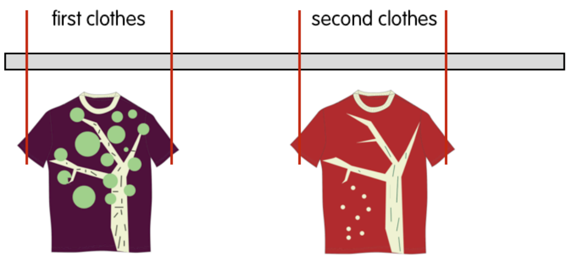

Figure 2: Ranges of clothes are stored (continuous case)

Based on the clothesline metaphor, because there may be various ways of input and output in the design of the interface, we discuss what kind of input and output is appropriate in this section. Not everything proposed here is applicable to the four individual interfaces because of the purpose and environment of each, but the followings are necessary for the ultimately ideal musical interface.

3.1 Input

In the clothesline interface, input can be a form of recognizing the gesture of hanging clothes itself or recognizing the clothes hung on the clothesline or clothes airer. In this work, we chose the latter because in order to use any article of clothing as a medium to interact with the interface, sensors and electronic circuits should not be attached on the clothes. In this case, recognizing the clothes is easier than detecting the movement of the body.

In order to measure how the clothes are hung, each sensor can be placed at regular intervals. In this way, there are a limited number of points along the clothesline that store the data on the hanging clothes (discrete case, Fig. 1). In contrast, ranges of clothes hanging on the line can be stored by using cameras (continuous case, Fig. 2). The former way can be implemented easily and clearly, but it does not separate the clothing and only determines the status of each point. However, in the continuous case, several virtual clothes objects can be created in the program. Creating individual sonic events becomes possible when ranges of the clothes items are stored.

One type of input for the points, or virtual clothes objects, along the clothesline is Boolean variable storing in an on/off state to judge whether the clothes are indeed hung. Another type of input is a continuous number that represents a unique characteristic of the clothes such as color or the state of the hanging clothes such as position, movement, and pressure.

3.2 Output

Basically, each points, or virtual clothes object, along the clothesline creates individual MIDI notes or plays sound samples by responding to the input. Thus, the user can experience a new sonic event from the speakers near the hanging clothes.

In addition, even if the same clothes are hung, users can experience various sounds by creating a different sonic event as the position is changed from side to side. To achieve this variety, each point along the clothesline has its own unique sound sample. Alternatively, a sound is also changed by controlling the volume balance between the loudspeakers as the position of the clothes.

A unique characteristic or the state of hanging clothes is used for a parameter of the MIDI note or the sound sample. This input varies the sonic event when the hanging clothes are different colors or when they are hung tightly or loosely. Thus, inputing unique characteristics creates a dynamic user experience.

According to the mapping types defined by Tanaka[8], the creation of a sound sample by recognizing an item is considered to be binary mapping. The number of MIDI notes or the balance between the speakers, which represents the position of the clothes, is considered to be basic parametric mapping. Changes in the parameters of the sound effects, which represent the characteristics of the clothes hung on the clothesline interface, can be considered to be expressive mapping. Although all implemented clothesline interfaces are not the same, the mapping strategy designed for the interface is complex mapping, which means that a single input is used for various output events.

4. IMPLEMENTATION

4.1 First work

The first clothesline interface was implemented for a simple demonstration in a short indoor performance (Fig. 3). In the performance, two 5m ropes were tied between two pillars to create a clothesline. By hanging and gathering several items of clothing, the creation of various sonic events was represented. Visual effects were also displayed over the hanging clothes by a projector.

In order to recognize the clothes, eight photo sensors were placed on two lines. First, the intensity of light without the hanging clothes was measured by each sensor because a change in light indicates a change in state (i.e., clothes are hanging or gathered). When latter decreases below the threshold, this system indicates that an item of clothing is hanging on the clothesline. In contrast, it indicates that the clothes are gathered when the value increases above the threshold. Moreover, by separating the threshold into several levels, we tried a kind of basic parameter mapping by creating different sonic events when the number of clothes hanging on the sample position was different.

We tried both ways of the sound output discussed above: MIDI note and sound sample. Because each photo sensor relates to its own MIDI note or sound sample, a different sonic event is created when the position of the clothes is changed.

4.2 Second work

The second interface is a large-scale interactive installation that can be installed both indoors and outdoors. Audiences can participate together in the performance by hanging their own clothes on a long clothesline. Thus, the characteristics of the second clothesline interface are similar to Soundnet[7], which emphasizes the quality of large scale and multiuser instrument.

This work was installed on the lawn at KAIST. A 50m

Figure 3: Performance with the first interface

Figure 4: The sonic event is expressed through the loudspeakers near the hanging clothes

line was placed and PVC pipes were used as columns to bear the long rope. Behind the line, there were several cameras to track the items of clothing hung on the clothesline, the computers, and the loudspeakers. Audiences could freely hang and gather clothes on the line. The response to hanging the clothes was expressed by the sonic event of a bell sound through the loudspeakers around the clothes (Fig. 4). The generated bell sound depended on the color, position, and sway of the clothes.

In the recognition process, the cameras decided whether or not the clothes were hanging and measured their position, color, and sway. These measurements were used as parameters for sound synthesis. The color decided the type of bell sound. The clothing position controlled the volume balance between the loudspeakers so that the audience hanging the clothes could hear the loudest bell sound. The movement value was utilized for reverberation effect, so the more a piece of clothing swayed, the stronger a reverberation effect occurred.

4.3 Third work

The third Airer Choir was developed for Incheon Digital Art Festival (INDAF), which exhibited interactive installations and art works during a month-long exhibit. Because the interface was required to be exhibited for public over a long period, durability was an important difference from the second work. Thus, although the metaphor of hanging clothes was still used for the work, pipes are used instead of rope as a visual representation of the work.

In the recognition process, a new method was used. Several tone holes were drilled along the pipes, a speaker unit was placed at one end of the pipe, and a small microphone was placed at the other end of the pipe. The signal from the microphone was filtered, amplified, and played by the loudspeakers. As a result, the resonant sound in the pipe depended on how the tone holes were covered by the clothes.

This work was installed in an outdoor exhibition space (Fig. 5). Four 2m pipes with speaker units and microphones at each end were suspended in the air. The resonance in the pipe was also played by the loudspeakers installed on the floor so that audiences could experience the sonic event by hanging clothes on the pipes.

Figure 5: The third Airer Choir interface exhibited in INDAF

Figure 6: The fourth Airer Choir interface exhibited in Studio SEMI

4.4 Fourth work

The fourth interface was developed for Studio SEMI, which exhibited the musical interfaces developed by the SEMI project during a period of two weeks. This exhibition focused on interaction with the audience, so durability was also important. Therefore, the overall shape of the work was similar to the third work as shown in Fig. 6.

However, we applied a different mapping strategy. A piezo sensor to measure the vibration was placed in the middle of a pipe. Thus, a sonic event of synthesizing a sound was generated when there was a vibration in the pipe, and the magnitude of the vibration was used for the reverberation effect and volume parameter. A difference from previous works was that this work recognized the pressure on the pipe created by hanging and gathering the clothes. The sound reverberated strongly when the clothes were placed firmly on the airer interface. The reason we used this mapping strategy was that because this work was installed in an indoor space, the continuous sound may have interfered with other works if is was played continuously due to the hanging of the clothes.

5. DISCUSSION

System	Focus	Media	Scale	Musical Ranges / Notes	Sensor	Directed Interaction	Mapping
First work	player	sound, image	1	limited, loops	photo sensor	no	binary(on/off), basic parameter(loop)
Second work	audience	sound	1-10	loops, delay, panning	camera	med-high	binary(on/off), basic parameter(loops), expressive(delay, panning)
Third work	audience	sound	1-5	pitch	microphone	low	basic parameter(pitch)
Fourth work	player, audience	sound, image	1-5	loops, delay	piezo sensor	low	binary(on/off), expressive(delay)

Table 1: Contexts of the musical interfaces using the clothesline metaphor

We classified the four interfaces discussed above as the criteria proposed by Blain[2] with the mapping strategy criteria proposed by Tanaka[8]. Because the four works use the same metaphor, some elements are identical. The common purpose of these works is to design an easy-to-use interface using a familiar object, so the learning curve is steep and there is no pathway to expert performance. Other elements demonstrating the difference between the interfaces are shown in Table 1.

By applying the variables differently according to the purpose and environment, we verified that the same metaphor could represent various musical expressions. Also, the works were designed to have high transparency because the clothesline metaphor is based on an ordinary object that is familiar to most people, and it indicates that hanging clothes is the gesture for interaction. Thus, audiences enjoyed the works easily without any instructions in the exhibitions (A video sample is available at **http://aimlab.kaist.ac.kr/∼asuramk88/clothesline**).

However, several limits of the metaphor exist. Because a fast interaction is impossible with this type of work, the performance may be lackluster without an ancillary element such as background music. In addition, ease of learning means that there is almost no difference between expert and novice, so the level of play may cause users to lose interest quickly.

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