A SMART BRACELET

An alternative interfaces between performer and audience

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Abstract. Performing arts has been one of the main recreational activities in people’s life. However, most performing arts, performers usually used one direction to express performing contents to the audiences. It means there is no real-time communication channel between the performers and audience in most performance. Hence the challenge of this research is how to provide a better relationship between the performers and audience without disturbing the show? This research we implemented a bio-sensor embedded smart bracelet which is able to transmit the feelings from user’s to stage by monitoring biological signal (ex: Galvanic skin response) immediately. When most audiences have the same physiological reaction to a certain level, the stage scene would be changed the colour and pattern to let performers know how the audiences’ feeling now. Performers would enhance self-confidence and then incorporate the audiences’ feedback to create their future performance. By applying this interactive interface to performing arts, we explored a new vision of performance that can not only enhance the diversity of performance but also provide a comfortable communication channel between performers and audiences, and improve the confidence of the performers.

Keywords. Performing arts; computational technology; interactive interface.
1. Introduction

The advent of digital technology has provided artists with more diversified media for creativity, and a new concept of “interaction” is integrated into their works of art. These works are presented in a unique manner that constitutes the so-called “digital art.” Artists attach much importance to the concept of “interactivity”, which is a characteristic of digital technology; this concept has become an approach for creation. As Ascott (1990) said, “Through the medium of art, one can interact with others, leading to communication between a piece of work and a person and engenders a new art value.” Digital art has transformed the traditional one-sided way of appreciating and understanding artworks; this implies that art works are not merely meaningful in aesthetics, and their values are derived more from the engagement of the audience. In other words, not only does digital art offer more diversified media elements and expressions, but it also changes the inherent means of communication between artists and audiences (Lin and Fan, 2004).

At present, digital technology has been applied to performing arts ranging from simple one-sided stage curtain projection (Rakkolainen et al, 2006; Shiba et al, 2010; Soga et al, 2009) or auto-rotating projection technology (Kim and Kim, 2015) to global projection (Anarchy Dance Theatre, 2011). These applications provide more space for artists to thrive. Performing arts, different from static arts, require the collaboration of two groups, that is, collaboration between the performer and audience to complement the works of art, and so two different types of interaction appear. The first one is the interaction between a combination of digital technology and theater space (background, music, props, etc.) and performers, such as the well-known Japanese performing group SIRO-A, who are good at employing projection technology to produce illusions. The second is to invite the audience to perform on stage and use sci-tech media to make some onstage changes, similar to what Seventh Sense performed at Anarchy Dance Theater in 2011. The integration of these performing arts with digital technology delivers fabulous visual feasts to art lovers as well as generates excitement over the future of digital performing arts.

2. Problem and objective

The brand new future of art is starting with digital technology. Many performing artists have tried to make use of science and technology to break the barrier between the performer and audience, such as the entertainment system to interact with audiences(Maynes-Aminzade et al, 2002) or the interaction system for impromptu story-telling (Alavesa et al, 2014). The number of
art installations that can facilitate interaction with audiences has been increasing. However, in performing arts, artists rarely use digital technology to interact with the audiences. Digital technology is mostly used for facilitating interaction between performers and theatre space.

Clayton Hamilton, an American critic, once said “The audience plays a significant role in a theater” (Yao, 2004). Anne Ubersfeld, a contemporary French theater scholar, also stated that although no audience is engaged in any part of theater production, the entire drama still exists for them (Chiu, 1997). The theory echoes with the interactivity of digital technology. Performing arts evolve even today nonetheless, but most of them are still caught in the framework of traditional arts. The performance on the stage will impact the emotion of the audience, but the emotional response of the audience cannot be conveyed to the performer. As a result, though audiences play an important role, they cannot engage themselves in the performance.

The interactive relationship between the performer and audience is still in a phase where audiences watch performances through the performers’ eyes. In this one-sided communication style, a performer is satisfied by his/her own performance but he/she is not able to determine the audiences’ thoughts. If suppose an audience reacts radically towards a performer (claps hands or shouts suddenly during a performance), the performer would get disturbed. Therefore, the main subject in this study is to explore a special interactive approach that can improve the relationship between a performer and his/her audiences without influencing the performance. This study seeks to utilize digital technology to improve the interactive relationship between the performer and audience. The approach involved a smart bracelet system prototype. More specifically, the physiological signals of the audience could be gained through biological signal sensing devices (mainly based on electric skin response). As the performance proceeds, the background projection on the stage slowly changes to minimize the possibility of influence from the audience on the performer. Simultaneously, performers could find out whether their performance was appreciated by the audience, through watching the changes on the stage, as indicated by the bracelet in real time. Thus, they could be encouraged and gain confidence that a better and more intuitive interactive system could be built.

3. Methodology and steps
In this study, we aim to change the interactive mode between the performer and audience in performing arts; an interactive system was proposed that uses people’s emotion as an intuitive response via the physiological signals of audiences. This arrangement sought to control the change in the image back-
ground on the stage so that the interactive response could be directly offered to performers. This study was mainly based on electric skin response and included the following two steps:

**Step 1. System Concept**

Even though digital technology has been widely applied to performing arts, there have been no studies for sensing physiological signals as a means of interaction. Therefore, the emotional changes in audiences who appreciate performing arts would be analyzed first in the study. Tsai (2013) discovered that the intensity of emotion changes in “The Emotional Expressions and Structure in Beijing Opera Pong-Yin: Combining Performance Analysis with Audience’s Physiological Measures” was the best physiological response to be sensed, and so we selected skin electric response as a sensing standard through the electric conductivity of fingers to detect emotions, and combined the above results to establish a framework of this interactive system.

**Step 2. System Implementation**

In order to prove the practicability and reliability of the smart bracelet interactive system in this study, a model of the smart bracelet system was established. First, the main program of the interactive system was installed to ensure it cascades image changes on the background projection in response to the audience’s physiological changes. At the same time, the assembly and testing of the wearable devices was carried out. Finally, the subjects were invited to have a scenario demonstration.

4. Result

4.1. SYSTEM CONCEPT

In order to improve the one-sided interactive relationship between the performer and audience, we built a good and intuitive interactive bridge between these two groups via a smart bracelet system (Figure 1). The study focused on the background projection in digital performing arts with a large audience with the same reaction to an increase in the image changes in the background. The more the people felt excited, the more evident the image transparency was. The demonstration of the image not only offered the audience a sense of satisfaction in participation, but also allowed performers on stage to know the feelings of audiences through the background changes on the stage.

The system included two major parts: one was the physiological sensing of a smart bracelet and the other was the image changes on the background
projection. The system must be built while on performance in a way that the audience can engage themselves with the performance on the stage in the prescribed periods via the setup of the performing party. The smart bracelet mentioned in the study is still in its development stage, so there had been no cooperation from any performing group yet. At present, the development of the system is the key part in the entire study.

4.2. IMPLEMENTATION OF SMART BRACELET SYSTEM

In this paper, we proposed a new architecture for interfacing the performer and audience. The audience, who has worn our smart bracelet, plays the role of source generator. This bracelet can measure galvanic skin response, establish a channel with a backend server, and transmit the data. Then, the performer can react to these sensing data, which show up as different colors depending on the feedback of the audience (Figure 2).

The first problem we have to solve is the connectivity between all the smart bracelets and back-end server. Fortunately, with the growth of Internet of Things (IoT), the bridge module between a microcontroller and Internet has been widely developed. Therefore, we choose the NodeMCU as our platform for the smart bracelet due to its low-power consumption and Wi-Fi connectivity. The following section will cover the details of our implementation of hardware and software, respectively.
4.2.1. Smart bracelet

The NodeMCU offers a complete and self-contained Wi-Fi networking solution. It provides a system-on-chip with integrated TCP/IP protocol on a microcontroller with a bunch of peripherals, such as UART, ADC and GPIO. Additionally, NodeMCU uses an on-board programmer, which makes the solution more portable and easy to use.

To measure the conductivity on the skin, we use a high precision comparator to compare the voltage difference between two fingers. Note that the ADC on NodeMCU is then applied to sample the analog signal on the comparator output. In this experiment, we select TI LM393 as our comparator. A voltage divider was needed to limit the ADC input to a maximum of 1 V, since LM393 has an output voltage of 3.3 V. The DC bias for TI LM393 is provided from NodeMCU.

The power solution on our smart bracelet is a small power bank with a mini USB cable plug into NodeMCU.

Finally, the program in NodeMCU keeps sampling the conductivity and sending it to the back-end server.
4.2.2. Back-end server

To handle hundreds of connections from the smart bracelet and render a responsive colour block, we need a computer running as a server. In this experiment, we choose Nodejs as our framework because of its event-driven and non-blocking advantages. During the reactive performance, the responsive colour reaction is accomplished by computing the average conductivity continuously and mapping to a colour. Note that the average process can be equal to a low-pass filter when the audience becomes larger. Therefore, the colour can change gradually and the index of the audience excitation can then be observed.

4.2.3. Scenario simulation

Maggie has just finished work and wants to relax by watching a show. When she enters the theatre (Figure 4-A), the staff helps her to wear a bracelet (Figure 4-B). She is not sure why she needs to wear it, but she takes her seat. During the show, she finds that when everybody laughs, the background becomes bright (Figure 4-C). In contrast, when nobody is responding, the background becomes dark. Actor looks poor (Figure 4-D). She thinks it is amazing and enjoys this show.
Figure 4. Scenario demonstration: A audience member enters the theater; B staff helps her wear the bracelet; C when the audience exhibits large changes in emotion, the background becomes bright; D when the audience does not exhibit any change in emotion, the background becomes dark; E the interface of GSR (left: another audience; right: Maggie) and bright background; F the interface of GSR and dark background

5. Conclusion and contribution

The future of performing arts is full of possibilities. In this paper, a smart bracelet has been proposed to measure the skin electrical resistance and report to performers. It not only provides a quantitative biological response to performers, but also enables real-time feedback from audience. The implementation of the smart bracelet system has proved the feasibility that physiological signals and interactive devices can be integrated, with the audience and performer satisfied. Since the system in the study is in its early stages, it still offers scope for development, such as the use and efficiency of wearable bracelets, the endurance of batteries, or the richness of image projection. The system can be applied to other spaces, such as the remote monitoring of home healthcare, to deliver the benefits of this intuitive and excellent interactive interface to users. Finally, the proposed smart bracelet system com-
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bines biological signal processing, Internet of Things and performing arts as a modern performing system.

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References


