Grasping Interface with Photo Sensor for a Musical Instrument

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Abstract. This paper introduces a luminance intensity interface driven by grasping forces, and its application as a musical instrument. In traditional musical instruments, the relationship between the action and the generated sound is determined by the physical structures of the instruments. Moreover, the freedom of the musical performances is limited by the structures. We developed a ball-shaped interface with handheld size. A photo diode is embedded in the translucent rubber ball to reacts to the grasping force of the performer. The grasping force is detected as the luminance intensity. The performer can use the ball interface only by grasping directly but also by holding to the environmental light or shading it by hands. The output of the interface is fed to the sound generator and the relationship between the performer's action and the generated sound is determined by the instrumental program to make the universal musical instrument.

Keywords: Grasping interface, Illumination control, Ball-shaped interface, Musical performance.

1 Introduction

Musical instrument is a device to translate human body motion to sound. In traditional musical instruments, the relationship between the performer's action and the generated sound is determined by the physical structures of the instruments. Moreover, the freedom of the musical performances is limited by the structures. Most of digital musical instruments which have interfaces imitating traditional instruments have the same limitations, although they are easy to play for the users who have experienced with traditional musical instruments. On the other hand there have been reported a lot of new music systems that utilize a haptic interface, a video and motion capture devices to create music according to human gesture and body movement [1]-[13].They introduce various types of sensing techniques to detect human motion, and the measured body movements are mapped to music or sound. One example is a magnetic based motion capture system [14]. Especially, a video-to-music system has been emphasized with the aim of investigating how to associate natural gestures with sound/musical features for interactive performance, for example [9][15] [16] [17]. Thus the advanced information technology has proposed a variety of new ways of music creation and performance to make people free from the physical limitations by providing different abilities on music creation.

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In this paper, we present a new type of grasping interface that detects the user's grasping and handling actions by luminance intensity for musical performance. Our goal is to realize a new interface that has the following features: 1) wireless communication, 2) handheld size, 3) intuitive operation.

Several approaches have been proposed to make handheld interfaces. Beatbug [18] is a bug-shaped musical controller. Although this instrument is similar to the mouse, it does not use wireless communication. GrapMIDI in our previous study [19], [20] is ball-shaped for easy handing and the material is silicon rubber. The ball-shape is one of the popular shapes for the interface of digital sports in the last few years. Sugano et al. [21] proposed "SHOOTBALL". This interface is not considered to apply the musical instrument though the ball is equipped with some sensors to detect the impact caused by users. BouncingStar [22] is also ball-shape. This is based on wireless technology and includes infrared and full-color LEDs and an acceleration sensor. It is well protected against shocks and bounces by using silicon rubber. The color and flushing speed of the LEDs inside the ball change in relation to the acceleration data. Although this device can illuminate, it does not receive the light signal. Moreover, the ball without digital devices is used for a lot of sports such as baseball, volleyball, and basketball etc. We are interested in the feature of the ball-shape that can be applied for a lot of applications. Therefore, we also employ the ball-shape for the interface of the musical instrument.

Fig. 1. Prototype of the proposed grasping interface

2 Structure of the Proposed Interface

Figs. 1 and 2 show a prototype of the proposed interface, the overview of the proposed system, respectively. The main body of the proposed interface consists of a rubber ball, a Bluetooth wireless module, a photo diode, LEDs, a PIC (Peripheral Interface Controller) and a battery (9.0 V). All electronics devices are enclosed in the rubber ball which represents translucent and hollow. In the rubber ball, the Bluetooth wireless module, the photo diode, the PIC, and the battery are deposited on the substrate. This substrate is fixed by urethane sponge inside the rubber ball. Moreover, LEDs are bonded interior the rubber ball. The specification of the rubber ball is as follows: diameter 152 mm, weight 245 g, material PVC (Polyvinyl Chloride). User grasps this interface, and then performs the control of the instrument by the grasping force.

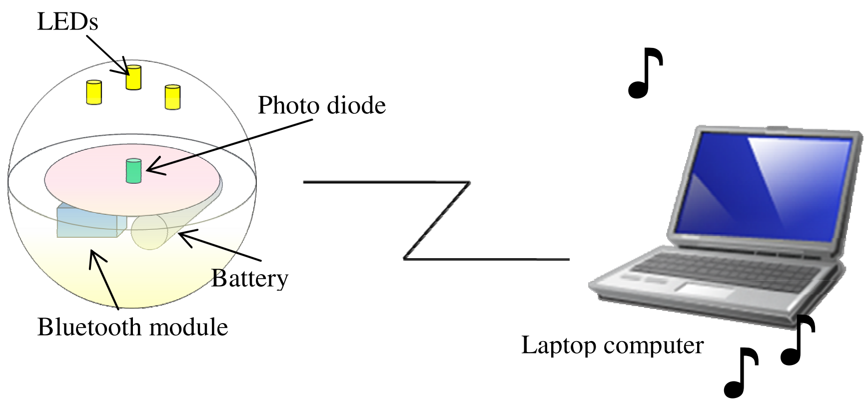

Fig. 2. Overview of the proposed system

3 Operation Procedures

When the rubber ball change its shape due to the grasping force of user, the distance between the photo diode which is embedded in the inside and LEDs varies as shown in Fig. 2. Consequently, the signal which depends on the grasping performance is obtained by the output value from the photo diode (i.e. illumination intensity varies). This output signal is inputted to the laptop computer as digital signal via Bluetooth wireless module.

Usually in the musical performance, the user contacts the musical instruments directly. On the other hand, there are some musical instruments like Theremin that can be performed without physical contact. Although the proposed interface can achieve the performance by detecting the grasping forces via the intensity of illumination, the proposed interface is able to perform using the difference of the illumination from outside of the ball because it is made of translucent rubber-ball. Therefore, it is expected that users can achieve a musical performance like Theremin performance to extend the degree of freedom of the performance style.

Fig. 3 illustrates the different styles of performance using the proposed interface as a musical instrument. Figs. 3.1 to 3.3 show the directly grasping performance. Users are able to perform the music by their hands or fingers actions. Figs. 3.4 and 3.5 show another styles by bouncing and throwing, respectively. In the case of the bounding and the throwing, the intensity of illumination varies according to the changed shape of the interface by the impact of bounding or catching. Figs. 3.6, 3.7, and 3.8 show the cases to use the ambient light such as a desk lamp. Especially, the case shown in Fig. 3.8 is similar to Theremin case where the user performs without contact.

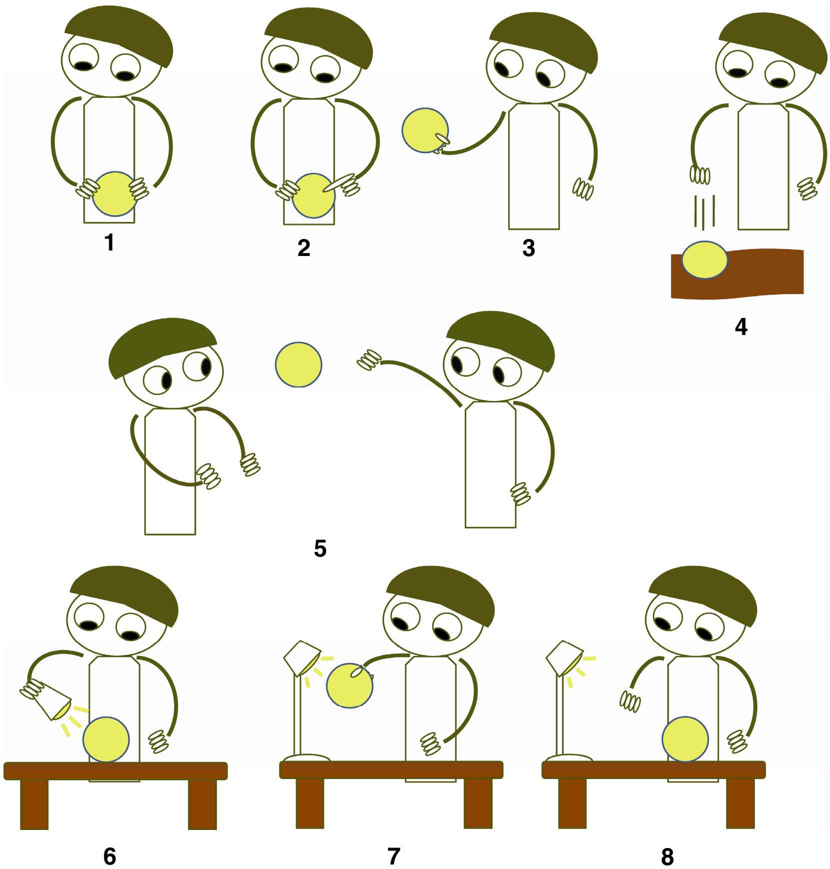

Fig. 3. Styles of musical performance. 1) Grasping by both hands, 2) Pushing by finger, 3) Grasping by one hand, 4) Bounding, 5) Throwing, 6) Lamp comes close to interface, 7) Interface comes close to lamp, 8) Shade the light by hand.

4 Application for Musical Instrument

We examined the musical performance by using the developed grasping interface with a photo sensor. We use the fluorescent lamp as an environmental light, and perform the experimental music in indoor room.

In this experiment, the user controls the musical scale depending on the grasping force and the positional relation between the environment light and the developed interface. Although the relationship between the action and the generated sound is determined by the physical structures of the instrument in the traditional musical instruments, the relationship in the proposed interface as a musical instrument is able to be set freely.

Fig. 4 shows the appearances of the musical performance when the proposed interface is used. Left and Right figures of Fig. 4 correspond to Fig. 3.1 and 3.7, respectively. The musical performance can be done with improvised manner in real-time.

Fig. 4. Appearances of the musical performance. Left: grasped by user, Right: closing to the fluorescent lamp.

5 Conclusion

A new type of luminance intensity based interface has been introduced. A photo diode is embedded in the translucent rubber ball to reacts to the grasping force of the performer. The performer can use the ball interface only by grasping directly but also by holding to the ambient lights or shading by hands. The output of the interface is fed to the sound generator and the relationship between the performer's action and the generated sound is determined by the instrumental program to make the universal musical instrument. The interface can be effectively used in embodied sound performance in general like the dance performance as it is not only wireless but also can be shaped arbitrarily. We are going to embed other sensors in the ball such as the acceleration sensor and pressure sensor for more expressive performances.

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