Balance Ball Interface for Performing Arts

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Abstract. This paper introduces a novel balance ball-shaped interface to translate human body expression to sound. Although a variety of mobile interfaces have been introduced for musical performance, most of them are small not to disturb performer's action. On the other hand the proposed interface is visible and large enough to act with human performer. All the sensors are equipped in a large balance ball which moves, rolls and deforms according to the performer's actions such as pushing and kicking.

Keywords: Balance ball interface, Musical performance, body expression.

1 Introduction

Digital musical instruments are devices to translate human body motion to sounds for musical performances. Recently, many digital musical devices have been proposed to generate sound based on human actions. Especially, *iPhone* has been used for the musical device. It becomes the most popular device because it has some sensors to detect the human actions. Therefore, there are developed many application software to perform music production and music editing [1][2]. As these researches used *iPhone*-based applications, they have been reported a lot of new music systems by developed the original devices based on a haptic interface, a video and motion capture devices [3-11]. These systems also can create music according to human gesture and body movement. We also have proposed musical interfaces [12-15]. *GrapMIDI*[13] and *TwinkleBall*[14, 15] are ball-shaped interface for easy handing. The sound is generated by grasping force and human motion. The performer can control the note and tempo by varying grasping force and motion, respectively. *TwinkleBall* is also able to generate the sound from the body expression and achieve the free-style performance. Most of existing interfaces are small not to disturb performer's action. On the other hand, we present a large ball-shaped musical interface in this paper. The proposed interface detects the user's actions by luminance intensity, acceleration and angular velocity and large enough to interact with human performer. It moves, rolls and deforms according to the performer's actions such as pushing and kicking. Our goal is to achieve a new body expression to create sound in the large stage performance.

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2 Structure of the Proposed Balance Ball Interface

Figs. 1 and 2 show a prototype of the proposed balance ball interface and the overview of the proposed system, respectively. The main body of the proposed balance ball interface consists of a rubber ball, a Bluetooth wireless module, a 3-axis accelerometer, a 3-axis gyro sensor, a photo diode, high intensity LEDs, a PIC (Peripheral Interface Controller) and two batteries (9.0 V). All electronics devices are enclosed in the rubber ball which represents translucent and hollow. The Bluetooth wireless module, the photo sensor, 3-axis accelerometer, 3-axis gyro sensor, the PIC, and the batteries are place on an electronic circuit board inside the core, which is fixed to the rubber ball using rubber tubes. In the rubber ball, the Bluetooth wireless module, the photo diode, the PIC, and the battery are deposited on the substrate. The LEDs are placed in the interior of the rubber ball. The specifications of the rubber ball are as follow: diameter 900 mm, weight 2.7 kg, material silicon rubber. As shown in Figure 2, the signal output from the photo sensor, the accelerometer and the gyro sensor are digitized and sent to an external computer via internal Bluetooth wireless module. In the computer, the *velocity*, *note* and *tempo* are calculated by using received values for controlling the MIDI sounds. The internal speaker on the computer or the connected external speaker outputs the sounds depending on the calculated the *velocity*, *note* and *tempo*.

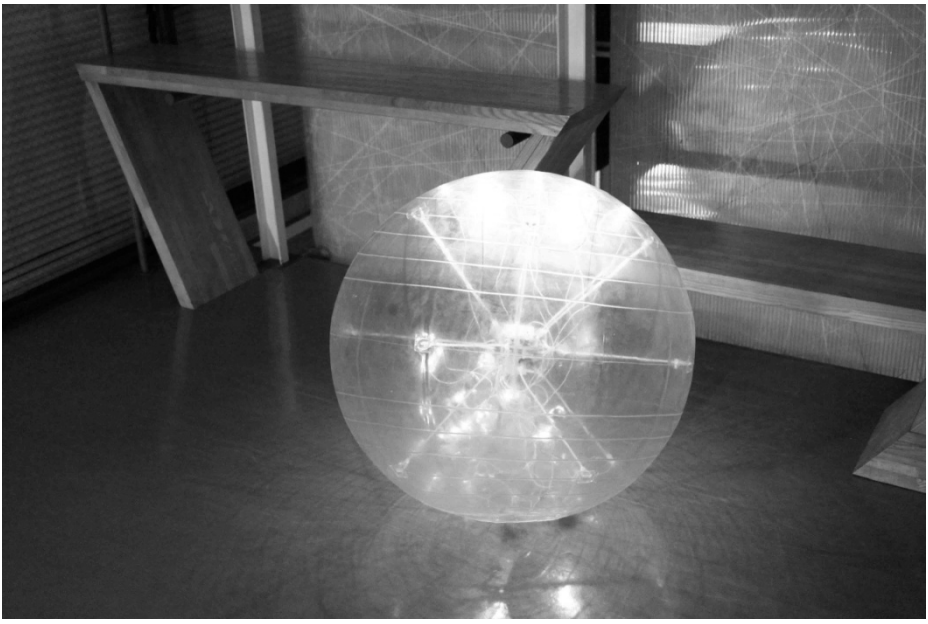


Fig. 1. Prototype of the balance ball interface

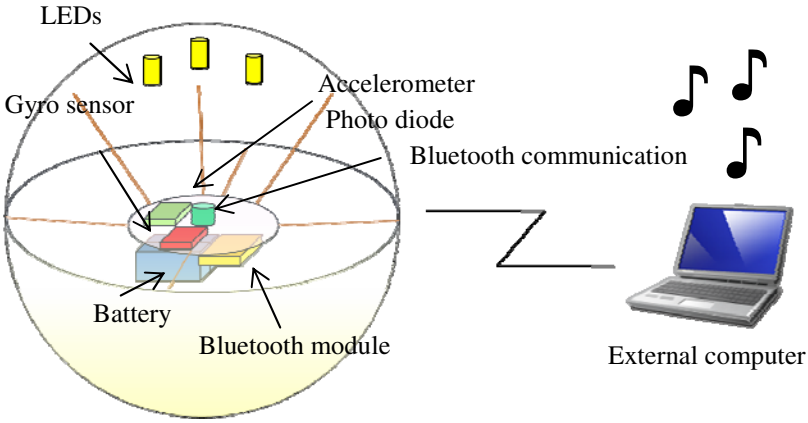


Fig. 2. Overview of the proposed system

3 Performing Styles Depending on the Human Body Expression

One of the features of *TwinkleBall* is hand-held size. Although it has throwing and bounding performances for the style of performance, the typical style of its performance is grasping performance [15]. On the other hand, the performing style by using the proposed interface is different because the size of the proposed interface is bigger than hand-held size. Figure 3 illustrates the various styles of performance using the proposed interface. Fig. 3 (a) shows the rolling performance. Users are able to perform the music by their hands or arms actions. Fig. 3 (b) shows lifting performance. User can be lifting the interface by both hands. The typical performance style of the proposed interface is riding performance as shown Fig. 3 (c). It is possible to perform music by riding on the proposed interface as if user performs exercise using a balance ball.

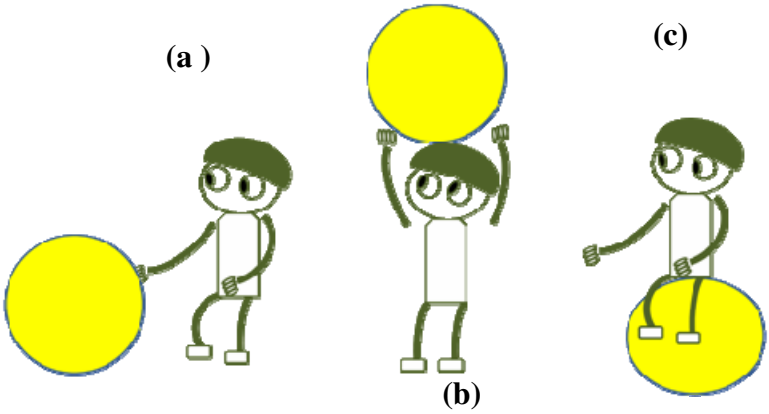
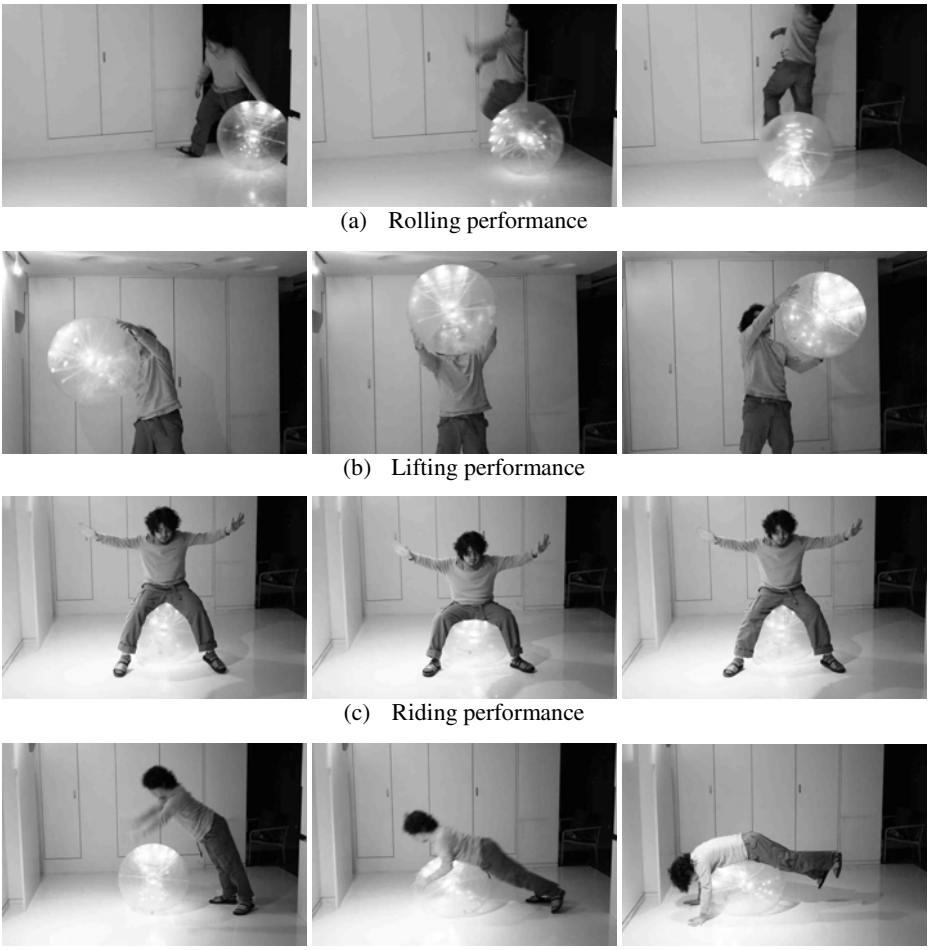


Fig. 3. Styles of musical performance. (a) rolling, (b) lifting, (c) riding

In the system, we use MIDI sound as an output of the generated sound. In this paper, the *velocity* is changed by the pushing force which is controlled by the luminance intensity. The *tempo* is changed by the angular velocity which is detected by the output of the gyro sensor. The *note* is changed depending on the gradient direction which is measured by the outputs of the gyro sensor and accelerometer. These setting are determined by preliminarily experiments.

4 System Configuration

In order to confirm the validity of the proposed balance ball interface, we perform the system confirmation. We verify 4 pattern performances. The typical performance styles by using the proposed interface are rolling performance, lifting performance and riding performance. Figure 4 shows the captured images during rolling, lifting



(a) Rolling performance

(b) Lifting performance

(c) Riding performance

(d) Diving performance

Fig. 4. Results of performances

and riding performances. In Fig. 4(a), the *velocity* is almost constant but the *tempo* and *note* are changed by human motion. Human controls the *tempo* by changing the rolling speed depending on the arm speed. The *note* is also controlled by the rotating angle of the interface. In Fig. 4(b), the *velocity* does not change during the performance but the *tempo* and *note* are changed by human action. Human controls the *tempo* by changing the speed of the interface using both arms. Then the *note* is also changed the gradient of the interface. In Fig. 4(c), the *tempo* does not change but the *velocity* and the *note* change depending on the riding motion and direction, respectively. Moreover, Fig. 4(d) shows the diving performance. Because the proposed interface is robust by using silicon rubber, it is possible to this performance style. The output sound is also same as the riding performance.

During the system configuration, the proposed interface can generate the body movement. Especially, the riding performance and diving performance are sort of new performance style. These are not possible by using the mobile interfaces. The proposed interface has the robustness feature. It is important feature to make the human interface.

5 Conclusions

This paper introduced a novel balance ball interface. The proposed interface can be expressed larger human performance such as rolling, lifting, riding and diving performances via the system confirmation. In the future, we are planning to apply this interface for performing arts. Moreover, we will perform the experiments about co-creation performance and sound by a number of users.

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