A Wii-based gestural interface for computer conducting systems

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Abstract

With the increase of sales of Wii game consoles, it is becoming commonplace for the Wii remote to be used as an alternative input device for other computer systems. In this paper, we present a system which makes use of the infrared camera within the Wii remote to capture the gestures of a conductor using a baton with an infrared LED and battery. Our system then performs data analysis with gesture classification and following, and finally displays the gestures using visual baton trajectories and audio feedback. Gesture trajectories are displayed in real time and can be compared to the corresponding diagram shown in a textbook. In addition, since a conductor normally does not look at a screen while conducting, tones are played to represent a certain beat in a conducting gesture. Further, the system can be controlled entirely with the baton, removing the need to switch from baton to mouse. The interface is intended to be used for pedagogy purposes.

Keywords: Conducting, Gesture, Infrared, Learning, Wii.

1. Introduction

Many computer-based conducting systems have been developed, for example [1, 6] which allow a user to conduct a piece of music using a digital system. We present a new Wii-based gestural interface for computer-based conducting systems. None of the current systems we have found enable the display of the actual conducting trajectory and real-time identification of beats within the gesture produced by the user, although systems do exist which display the coordinate location of detected beats [1]. This display, combined with the ease of setup and the affordability of the equipment make our system a significant advance from the current state of computer-based conducting systems.

2. Implementation

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NIME09, June 3-6, 2009, Pittsburgh, PA
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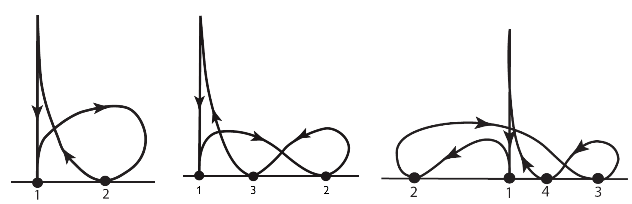
This system is developed using Max/MSP/Jitter [1] and Java. The user stands in front of the computer and the Wii remote is mounted with the camera pointing toward the user. The accelerometer functionality and buttons on the Wii remote are ignored. Unlike other video-camera-based infrared systems, no positional configuration is required. The infrared baton is held in the user's right hand. It should be noted that as long as the camera in the Wii remote can "see" the entire conducting window, the specific location of the Wii remote is irrelevant. The setup should be configured so that the user has full range of conducting motion and is comfortable during conducting. The system can also be set up using a laptop on a music stand, making it convenient for real-world conducting in front of an orchestra. The results are presented to the user both visually and aurally, so the user can attend to one or the other depending on the context.

2.1. Gestures and tracking

Figure 1 shows the motion of the tip of the baton (or of the hand) for three typical expressive legato gesture patterns.



(a) $\frac{2}{4}$ pattern (b) $\frac{3}{4}$ pattern (c) $\frac{4}{4}$ pattern

Figure 1. Typical conducting gestures, as seen by the conductor (after [3])

The infrared camera in the Wii remote tracks the movement of the right hand, or more specifically, the tip of a baton held in the right hand. DarwiinremoteOSC [2], an open-source software interface written for the Macintosh operating system, converts received sample data into Open Sound Control (OSC) [4] messages and delivers them via the User Datagram Protocol (UDP). During conducting, an infrared baton is held in the right hand of a conductor as an infrared light source. It consists of a conducting baton, a button, a one-cell battery holder, a 1.5 volt AAA battery and an infrared LED (Vishay CQY36N T-3/4 package 1.3V 100mA

[1] http://www.cycling74.com
[2] http://code.google.com/p/darwiinosc/

950nm) as shown in Figure 2. The button has to be pressed by a condutor's thumb while being used. Further, a glove or single-finger sheath can be constructed containing an infrared LED which will serve the same purpose.

Figure 2. The infrared baton

2.2. Main window

The main window is shown on a monitor. The menu contains five options to support two types of gesture recognition and the gesture following. Any option can be chosen while the focus is in the menu area. The conducting window displays the trajectory of the infrared baton and beat information, while it contains the focus. Although the system is designed to be driven entirely by the infrared baton (as shown in Figure 3) and not require a mouse for selection of options, a version of the system has been developed which makes use of mouse input as well.

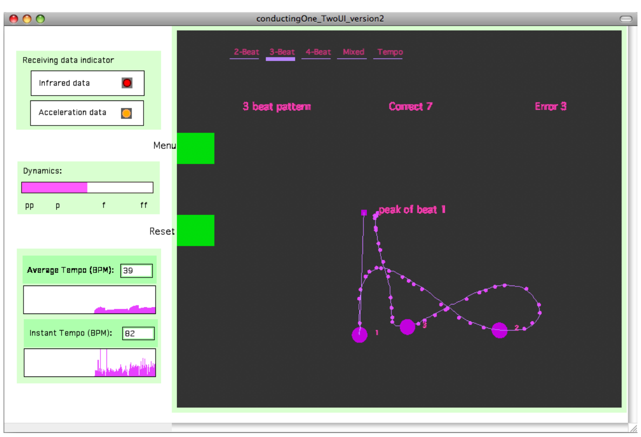


Figure 3. The baton-driven version of the main window, showing a 3-beat pattern successfully recognized. See Figure 1 for the corresponding ideal pattern.

2.3. Visual and audio representation

Because the coordinates of the tip of the infrared baton are measured directly, it is a simple process to draw the path of the infrared baton on the conducting window. Figure 3 shows an example of a three-beat ($\frac{3}{4}$) gesture recognized by the system. This system also supports audio representation for a conducting gesture, in order to allow a conductor to keep visual contact with an orchestra. An individual musical note is associated with each ordinal. For example, C4 is associated with the downbeat of any gesture.

2.4. Data analysis, gesture recognition and following

Data analysis picks up the vertical maxima and minima from the coordinates that comes from the Wii remote and passes them to gesture recognition and following according to inherent characteristics of conducting gestures [2, 3]. There is insufficient space here to detail the complete algorithm.

During downbeat recognition, the previous n samples are considered once a beat is detected. If they are directly vertical (within an angular tolerance ϵ) to the coordinates of the recognized beat, the beat is considered a downbeat and identified as the beginning of a new beat pattern gesture.

This system has two types of gesture classification. A general beat recognition is implemented that counts beats but does not identify whether or not the beat pattern is correct. It is started once a downbeat is found and ended when next downbeat occurs. Thus, the number in the counter reveals which beat patttern was conducted. Another classification supports three most common beat patterns (from 2 to 4 beats per measure). The beat pattern to be used has been known beforehand. Automatic detection of gestures is possible based on the horizontal position of the beats and the general shape characteristics of the trajectory [5]. A gesture is regarded as correct only if all beats are conducted correctly as shown in Figure 3.

In tempo tracking, instantaneous tempo is calculated as the inverse of the time elapsed between beats. Average tempo is a moving average of the previous n instantaneous tempo measurements. "10" is chosen through experimentation.

3. Conclusion

We present a gestural interface that uses the infrared camera built into the Wii remote and an infrared baton to track conducting gestures of the right hand. Visual display of the conducting trajectory is presented along with detected beats and beat ordinals. Audio representation displays the beat ordinals as ascending musical tones. The interface can be used for pedagogical purposes, such as learning and practice of beat patterns.

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