Demonstration of Sympathetic Orchestra: An Interactive Conducting Education System for Responsive, Tacit Skill Development

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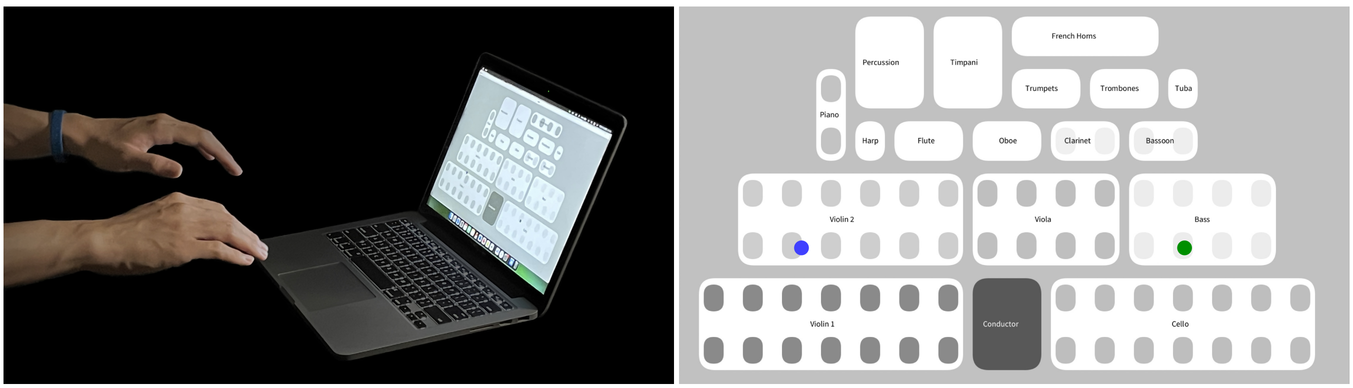

Figure 1: Sympathetic Orchestra is a dynamic virtual symphony orchestra, featuring an interface designed to mirror the layout of a real symphony orchestra. Users can use their hands and faces to direct and can receive responsive feedback.

ABSTRACT

Students learning musical conducting often practice along to static recordings, which do not provide real-time feedback similar to that of a live orchestra during rehearsals. Novice conductors need better solutions for practicing with feedback that mimics the experience of conducting a live orchestra. We can leverage emergent multimodal and spatial interaction technologies to support a "virtual orchestra" practice experience that allows students to develop tacit, live-practice knowledge. Through formative interviews with conducting experts and students, we designed and developed a dynamic, multimodal interaction system that targets key goals held by students developing their orchestral conducting skills, and that traditional practicing methods lack support for. Sympathetic Orchestra is an interactive virtual orchestra system that uses Google AI edge-powered Computer Vision hand and face tracking on webcam data to responsively interact with dynamic audio music playback and develop tacit practicing experiences.

CCS CONCEPTS

• **Human-centered computing** → **Interaction paradigms**.

KEYWORDS

Interaction Design, Conducting and Music Education

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1 INTRODUCTION

Conducting a symphony orchestra is a professional job with a well-established educational system and a long history. In conducting education, where students are training to conduct a symphony orchestra, there are significant gaps between the student learning experience and actual live performance experiences. Although the methods commonly used in the educational process (playing static

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recordings or conducting to piano players) can roughly simulate the experience of conducting a symphony orchestra to a certain extent, the (visual, audio, and spatial) limitations of these methods impede students' ability to develop the tacit knowledge, and confidence necessary to conduct a real symphony orchestra. These methods also impede the development of higher-level creative expression and interpretive exploration, and instead tend to create a static, one-dimensional practicing experience that is inaccurate to the responsive, modular, spatially and temporally dynamic experience of conducting an orchestra.

Emerging interaction audio computing technologies, as well as rapid advancements in computer vision offer new possibilities for supporting students learning to conduct. Our system offers an intuitive, accessible solution to supplementing this gap.

In this demonstration, we present Sympathetic Orchestra, an educational creativity support system designed to assist in conducting education and practice. Users can use their hands and faces to direct a dynamic virtual symphony orchestra, featuring an interface designed to mirror the layout of a real symphony orchestra. They can receive the responsive feedback necessary to develop tacit knowledge, with features that support understanding, practice, error reminder, as well as the opportunity to develop higher-level creative expression and style in an interactive musical playback experience that dynamically responds to their interpretive choices as a conductor.

2 BACKGROUND & MOTIVATION

Our work builds on previous research[11][7][12][10][9][17][2][13][16], educational theories[1][8][20][5][14][3][6], and design frameworks[21][15][19]. The Inspect, Embody, Invent Design Framework for Music Learning[21] in particular motivated the design of a system that would first support a conducting student in understanding a piece, then seamlessly continue to support them as they start to embody, invent, and creatively interpret. Prior studies have explored how virtual orchestras that simulate the timbre and feedback of real symphony orchestras can effectively help conductors practice[11][7][12][10][9]. Sarasua et al. used computer vision supported gesture recognition for controlling the mixed audio playback of different orchestral sections[17]. Ivanova et al. explored how visual feedback can help students better learn a piece during the practicing process [9]. BeaudoinLafon et al apply Goodwin's concept of professional vision to color grading to explore how a system can be designed to support individuals developing professional vision[8][4]; the design of Sympathetic Orchestra lends from experts in conducting education to support the development of "professional hearing".

On the surface, achieving these functions may seem as simple as mixing in a Digital Audio Workstation(DAW), but it can be a challenge to design educational tools and processes that effectively build tacit skills useful in real-world practices. We designed this interactive system using educational theories from Professional Vision[8] and the Inspect, Embody, Invent design framework[21], making the system an effective tool for assisting in conducting education and practice. We then developed the system using p5.js for an accessible web-based interface, Google AI Edge for real-time hand and face tracking and gesture recognition, and Web Audio APIs for rich, dynamically responsive audio playback and mixing. We plan to evaluate the system's effectiveness through micro-analysis[18] of the students' multimodal utterances as they explain and use the system, assessing the cognitive ergonomics of the system in the students' intuitive perception-action loops, and examining how the sound output serves as feedback shaping their skill development.

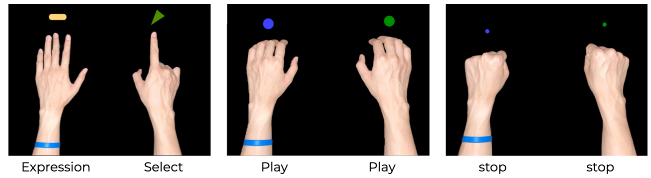

Figure 2: Gestures and corresponding cursors.

Function (Action)	Description
Expression(*palm spread*)	Changes the modulation of the music, such as dynamics and expressiveness.
Select(*finger point*)	Selects a specific part.
Play(*relax naturally*)	Continues playing.
Stop(*fist*)	Stops playing.
Tempo(*conducting gestures*)	Controls the tempo according to the score and corresponding beat.
Cueing(*cursor appears one beat in advance in the corresponding part*)	Cues the part that is about to start playing.

Table 1: Available functions in the prototype and their corresponding actions and explanations. The actions control the audio, providing real-time sound feedback during the conducting practice process.

3 LEARNING AND PRACTICING WITH SYMPATHETIC ORCHESTRA

Sympathetic Orchestra uses a webcam and computer vision to recognize gestures and process audio to simulate the realistic sound feedback of a symphony orchestra. The interface provides responsive visual feedback, a feature that existing conducting education and practice methods lack.

To help understand the music, our prototype also provides background information about the music, visual feedback during the practice process, and recording and playback functions.

4 USAGE SCENARIO

To motivate our prototype, consider the following scenario:

Herbert is an undergraduate student studying symphony orchestra conducting. He wants to perform Rachmaninoff Piano Concerto No.2 with his pianist friend Alexis in an upcoming concerto competition. Before rehearsing with the actual orchestra, he hopes to hear the sound of the orchestra collaborating with the piano to help him think about further musical processing. He hopes this practice process will help him prepare to conduct a real orchestra.

Getting Started. Herbert and Alexis come to the practice room. Herbert connects the computer to the stereo monitor speakers in the practice room and selects Rachmaninoff Piano Concerto No.2. The screen displays the background of the work composed by Rachmaninoff, and Herbert learns that the piece was dedicated to the psychiatrist who saved the composer.

Practicing. Herbert begins conducting the Sympathetic Orchestra while Alexis plays the piano. Initially, the visual effects on the interface indicate the parts Herbert forgot to cue. As Herbert practices, he develops tacit knowledge of the piece and becomes more familiar and confident with its movements. He practices the body movements in his hands, arms, and face that he learned in class to cue and direct each section of the orchestra in time with the music.

Iterating and Sharing. As Herbert becomes more and more familiar with this piece, he begins to experiment with his creative interpretation. Herbert and Alexis have several different creative ideas for handling the piece and want to compare them, as they consider what adjustments might guide the orchestra to collaborate with the piano. The Sympathetic Orchestra interactively responds to Herbert's movements as they try different tempos and modulations for different orchestral sections. At times they choose to highlight the piano, and at other times, the clarinet; they listen to the mixed harmony as they experiment with signaling different timbres for the wind and string instruments, attempting to evoke a variety of emotions throughout the piece. Herbert uses the recording and playback functions to compare five different handling methods across more than 20 sections, eventually finding an approach that he believes best expresses his musical understanding while achieving a delicate balance with the piano, and preparing him for rehearsal with a live symphony orchestra.

5 DEMONSTRATION SETUP

Our demonstration setup includes a laptop running the prototype interface, a webcam, and a set of stereo speakers, configured with several usage examples and tutorial sheets.

6 CONCLUSION

We demonstrate an interactive system designed to assist in professional conducting education and practice. Built on p5.js, Google AI Edge, and Web Audio APIs and informed by theoretical frameworks and formative interviews with conducting experts and students, our prototype offers a new solution for conducting education. It uses computer simulation to create a dynamic, responsive multimodel spatial practice experience to better develop skills to prepare students for conducting a live symphony orchestra. In this demonstration, users can explore the art of conducting on their own computer.

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