Mirror Mind: New Possibilities for Overall Interactive Design in New Music-Media Theatre

Yi Qin
Shanghai Conservatory of Music
qinyi@shcmusic.edu.cn

Da-Lei Fang
Shanghai Conservatory of Music
fangdalei@shcmusic.edu.cn

Zhi-Bo Xu
Shanghai Normal University
xuzhibo@shnu.edu.cn

Yan Da
Dada Hypermedia Lab
ddavidda@gmail.com

ABSTRACT

In this paper we describe the overall Interactive design of *Mirror Mind*, which is a New Music-Media Theatre art work. *Mirror Mind* is a cross-over experiment combining dramatic performance, live percussion, interactive multi-channel electronic music and new-media visual arts. By using multi-layered interaction and connection between performers and electronic music, performers and video, electronic music and video, etc. *Mirror Mind* expects to explore the deep nature of human being by rendering the reciprocal reflection of ones inside and outside world with a pan-acoustic narrative approach.

1. INTRODUCTION

*Mirror Mind*, a New Music-Media Theatre art work, created for Kunqu performers, live percussion, interactive multi-channel electronic music and new-media visual arts as whole; uses a 4 channel quad speaker system, main Screen-A (an orthographic projection, whose screen is made up by slices of paper) and Screen-B (a rear projection, 1.8 x 4.5 m). See Figure 1.

In Mirror Mind, the Kunqu performer has the leading role and the percussionist is in charge of most of the music section. Their movement and sound information are converted to generating several virtual "reflections", also called digital illumination, with which performers communicate to initiate a dialogue between sound and image in multi-dimension space.

*Mirror Mind* was co-presented with the Asia Society and the China Shanghai International Arts Festival, performed at the Coil Festival in New York.

2. INTERACTIVE SYSTEM FOR CONTROL AND DATA CAPTURE

In the work of *Mirror Mind*, the control and data capture system in this whole interactive design includes wireless on-
body sensors, Depth Camera (Kinect), iPads and a MIDI controller.

The wireless on-body sensors transmit the Kunqu performers movement and orientation. Accelerometers and gyroscope sensors are used to acquire this data. A commercial sensor system such as Motion Pod 3 from Movea can get a nearly perfect result. We also use some DIY sensor platforms such as WIS Platform from SHCM[1] (see Figure 2), and the result is also very good. The data is converted to OSC messages for audio and video computers. Depending on the type of the sensor, a computer may be required for data processing and conversion. We have built a simple Max patch for Motion Pod 3 to manage the sensors and convert the raw data to OSC messages. WIS Platform can be used directly, since WIS Platform can output OSC messages.

![Figure 2. WIS Platform - sensor nodes.](image)

Depth Camera (Kinect) captures performers body movement and transmits the skeleton information to the video computers which are running Max/MSP/Jitter. The skeleton information is used for generating virtual characters and changing visual effects.

A MIDI controller is used for scene switch, parameter control and sensor fail safe backup. The controller is controlled by the composer. Since the audio computer also sends MIDI data back to the controller for value change confirmation, motorized faders are required for the controller. The Behringer BCF2000 is by far the most suitable controller.

Three iPads, controlled by a visual artist, are in charge of cue switch and parameter control of the videos.

To make tight integration between the control system and audio and video computers, a local Ethernet network is built. Raw sensor data, selected live audio signals and various Max/MSP/Jitter information are transmitted over the network. A 100Mbit/s network is enough for data transmission. A router is not required since all the computers use static IP addresses. See Figure 3.

![Figure 3. DIAGRAM of Interactive System.](image)

3. AUDIO TECHNIQUE

3.1 Mirror Mind Sound System

The sound system includes the following sub-systems: microphones, a mixing console, a computer, a multi-channel audio interface and a quadraphonic speaker system.

Both wired and wireless microphones are used in Mirror Mind.

The wired microphones are used for percussion. For sound reinforcement, we use standard dynamic and condenser microphones, such as Shure SM57 (small gongs) and AKG C414 (big gong). For effect processing, we use miniature microphones such as Sennheiser MKE2. These microphones are put under the small gongs since the small gongs are played very softly during the effect processing part, and the effect processor uses many resonance filters. By using this miking method, audio feedback will be unlikely to happen. A typical wired microphone setup includes 4 dynamic microphones, 1 large diaphragm condenser microphone and 5 miniature microphones.

The wireless microphones are used for the Kunqu performer. One head worn miniature microphone is used for miking performer’s vocal, such as Sennheiser HSP2. One miniature microphone is used for miking the sound of the bowl, such as Sennheiser ME4. This microphone and transmitter are put inside the bowl. The transmitter is packed with a soft cloth to prevent generating noise when the bowl is vibrating.

All these microphone signals are fed into a mixing console, and the console routes them to 8 buses/aux sends/mixes. 4 of them are used for quadraphonic speaker system. 3 of them are used for sending signals to the audio interface. The last one is used for reverb processing, either to audio interface or to a dedicated outboard reverb processor.

For the audio interface, a typical 4 inputs/4 outputs audio interface is preferred. Audio processing and sample playback is done in Max/MSP which is running on a computer. A typical setup for these are a Windows PC and a RME Fireface 400 audio interface.

The quadraphonic speaker system includes four full range speakers. A typical setup for these speakers are Meyersound UPA-1Ps with USW-1Ps.
3.2 Software System

All the sensor data processing, audio effect processing and sample playback are done in a Max/MSP patcher. See Figure 4.

The patcher includes the following sub-patchers:
- Sensor data processing patcher converts sensor data to triggers and continuous control changes. For detecting triggers, most of the parameters are adjustable to fit different kinds of sensors, such as threshold, detecting window and re-trigger safe. All the parameters can be stored to different presets for fast recall.
- Percussion effect patcher processes small gongs sound by using frequency domain delays and harmonic resonance filters. Frequency domain delays use different delay time, equalizer and feedback levels on individual frequency passband. All these parameters are modulated by a common LFO. For harmonic resonance filters, 20 high-Q band pass filters is used. The frequency of each filter is decided by a base frequency and a multiplier. These filters create a metallic harmonic sound.
- Reverb effect patcher processes Kunqu vocal and other percussion sound to simulate a dream like scene. A plate type reverb is used to avoid any hint of acoustic space.

Sample playback patchers play back preset audio files as background audio. 5 playback decks are built because playback may be overlapped if the Kunqu performer performs faster than expected. The playback can be triggered by Kunqu performer and composer. 5 individual faders on the MIDI controller are used for volume control of each deck. The 5 LEDs on the buttons above the faders will indicate the most recent playback deck.

Switch sample playback patchers also play back preset audio files, but only 2 playback decks are built. Crossfade will be applied when playback switches from one deck to the other deck. The playback can only be triggered by Kunqu performer. The playback volume is controlled by Kunqu performer’s movement.

Trigger sample playback patchers playback short audio files. Up to 16 playback decks are built because these playbacks are intensively overlapped. The playback can only be triggered by Kunqu performer. Above patchers are all 4 channel audio output, either by surround panner or by multi-channel audio files.

Cue patcher controls overall states of different patchers, such as parameter status setup, audio processing on/off and playback files set change. There are 33 cues in Mirror Mind. The cue is triggered by the Kunqu performer or composer which is depend on different cues. To avoid any false trigger of the cue, self-locks and interlocks are used. Self-locks prevent multiple triggers from one source. Interlocks prevent wrong trigger source. A display system is built to show the current trigger source.

During the patching, poly is intensively used in the sample playback patchers to reduce the CPU usage. On a not so modern Intel Core Duo P8600 CPU, the average CPU usage is about 25% and the peak is about 45%. On an Intel Core i7-4650U CPU, the average is about 13% and the peak is no more than 20%. See Figure 5.

4. VIDEO TECHNIQUE

In Mirror Mind, a digital system is created to enable real-time dialogue between live gesture and two visual "egos", depicted as a virtual character and a dual digital shadow. Various technology is adapted including motion capture, wireless gesture sensing, procedural audio/video interaction and projection technique. A depth camera (Kinect) is used to capture performer’s live gesture and wearable motion sensors, as well as all live audio signals generated on stage. In the meantime, all those properties constantly communicate with the digital shadow from the performer, mixing the performer’s physical motion and virtual “ego” within a responsive media environment on stage. The visual system consists of 2 inter-connected Macs each running a different Max/MSP/Jitter program (see Figure 6), generating the virtual character and the shadow, while 3 iPads and an inner wireless network are used to control the system parameters on the run. During the performance, there is a constant data exchange between the visual and the audio output.
processing system, creating a meaningful linkage between all different kinds of media elements on stage. For example, the volume of the Kunqu performer’s voice is controlling the screen intensity of Screen B, and the dynamic parameter of Screen A is controlled by the overall volume.

![Main Window of Visual Patcher](image)

**Figure 6. Main Window of Visual Patcher.**

5. CONCLUSIONS

*Mirror Mind* uses New Media Theatre which is all built by interactive design concepts, in which two performers try to talk with the digital illumination and his reflection in mirror initiating a dialogue between sound and image, as well as exploit multi-layered interactive design between audio and video to present a series of wobble, distortion, metamorphosis and sublimation states. In the meantime, when working on *Mirror Mind*, we discovered that the traits of interaction can fit the improvisation of Chinese traditional opera to the highest degree, making it more easy and free for performers to master the rhythm of the scene of the drama. For example, it is the multiple interactive design in Mirror Mind that render the best and the most brilliant performance of Kunqu performers.

Acknowledgments

We would like to thank Prof. Qiang-bin Chen at SHCM for a number of suggestions and discussions on this project as well as Wu Shuang and Zhang Zujing for their perform to this project. Jialiang at SJTU also has helped for the WIS Platform.

This work is supported by the following programs or projects: Special Cultural and Technological Development Program of STCSM under grant No. 13511507800; Research project of Humanities and Social Sciences in the Chinese Ministry of Education, Project approval number 13YJC760101; Shanghai Local Colleges “Twelve Five” Connotation Construction - Shanghai Conservatory of Music, ”World-class Composition Discipline Group Construction”. The authors from SHCM are supported by Shanghai Key Laboratory of Musical Acoustics Art.

6. REFERENCES