

SONICTAIJI: A MOBILE INSTRUMENT FOR TAIJI PERFORMANCE

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ABSTRACT

SonicTaiji is a mobile instrument designed for the Android Platform. It utilizes accelerometer detection, sound synthesis, and data communication techniques to achieve real-time Taiji sonification. Taiji is an inner-strength martial art aimed at inducing meditative states. In this mobile music application, Taiji movements are sonified via gesture detection, connecting listening and movement. This instrument is a tool for practitioners to enhance the meditative experience of performing Taiji. We describe the implementation of gesture position selection, real-time synthesis, and data mapping. We describe outcomes of subjective tests of the user experience.

1. INTRODUCTION

Music applications for smart phones is a growing segment of the market. *SonicTaiji* is an expressive sonic and gestural interface created for mobile phones aimed at enhancing the Taiji experience by providing sonic feedback on the accuracy of movements and facilitating the meditative quality of Taiji through ambient sound. Our concept uses two Android phones affixed to a pair of fingerless sports gloves (Figure 1). First we wrote the Android app, *SonicTaiji*, which detects real-time gesture information. Each phone runs the app independently, detecting movement with accelerometer sensors. Furthermore, we developed a custom algorithm to detect specific Taiji styles. We linked this app to libpd [2] to generate sound. In addition, *SonicTaiji* provides options for performers to select different modes of sound. To refine the app, we collected user feedback.



Figure 1: Screenshot of *SonicTaiji* app and Performance



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2. BACKGROUND AND RELATED WORK

SonicTaiji is the third known project combining sonification and Taiji. In [4], the authors created a motion capture system using Wii Remote controllers in live performance. In the sound installation *Sonic Taichi*, the authors captured movement data to produce visual and audio displays [5]. In both cases, the end result was an art presentation. In contrast, our approach to Taiji emphasizes meditation and music therapy by providing user interaction through mobile devices. In particular, meditation music therapy has been shown to help people adjust their body function to improve recovery from medical procedures and rehabilitation for various diseases, including coronary artery disease and osteoarthritis, and for stress release [2].

3. DESIGN

We designed this app for the type of Taiji called “Twenty-Four Styles Taiji”, in which each style contains several gestures. Each style is vividly named, such as “Part the Wild Horse’s Mane”, “Playing the Lute”, or “Grasp Sparrow’s Tail in Left Side” [2]. Using x, y, z, data from each phone, we performed gesture detection via the system shown in Figure 3. First, we generated 40 gesture position templates, each containing thresholds of six accelerometer data. Accelerometer variables corresponding to the x, y, and z coordinate detected by the phone on the left and right hands. During performance, the sample rate is one millisecond, and each sample consists of six data values obtained by the accelerometers, which is in turn transmitted as a sequence. The data is then smoothed using low-pass filters to reduce noise. Finally, the system analyzes the smoothed data, and selects the best matched gesture template in the database. While our approach is relatively simple, the precision of the gestures in each of the twenty-four styles constrains the difficulty of the matching task. The result of which is a game-like experience, where users are sonically rewarded for correct spatial gestures. Style selection restricts the possibility of mismatching by limiting the number of possible mismatches.

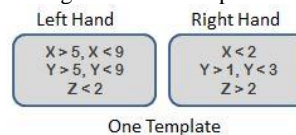


Figure 2: A Template Example

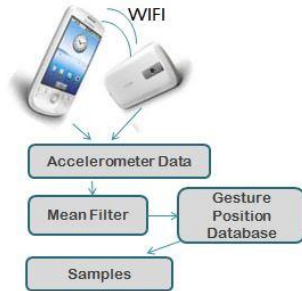


Figure 3: Gesture Selection System

4. IMPLEMENTATION

In our system, two phones independently run the app to detect gestures in real-time and map data to a particular synthesizer mode. We implemented the real-time sound synthesis module using the libpd [2], and utilized different layers of background sound for accompaniment. Other samples selected are closely related to the name of each style. We used the libpd comb filter and phase vocoder objects to process the samples and store them in the app to be triggered. We then used WIFI communication between the phones to exchange data, and used the built in speakers for the audio playback. We were concerned that the performer might have trouble hearing the sound when doing certain gestures, but instead the spatial effect becomes an integral part of the experience.

4.1. Performance Mode and Mapping

We provided users two performance modes, FM synthesis mode and natural sound mode. The FM synthesis mode is fairly simple, as it uses audio control parameters including carrier frequency, modulation frequency, and volume. The natural sound mode uses selected samples. During a performance, when a certain gesture has been detected, libpd objects trigger corresponding samples. In the FM synthesis mode, the gesture data is mapped to carrier frequency and modulation frequency. For example, carrier frequency increases if the accelerometer data of x and y axes increases. In the natural sounds mode, certain samples are mapped to certain gestures (See Table 1).

Table 1. Selected Sound and Corresponding Styles

Name of the Styles	Sound Source
Commencing Form	Cricket
Play Pipa	Pipa
Single Whip	Metal percussion

5. TESTS AND RESULTS

We did the subjective evaluation with 9 subjects, all of whom are students at Dartmouth College and who all have different levels of experience performing Taiji. The questionnaire we gave to each subject included three five-point Likert scale

questions and two multiple-choice questions. First we let subjects perform Taiji without using SonicTaiji. Then, we asked subjects to perform with SonicTaiji. Finally, we asked subjects to answer the questions. Below we list the question 1-3, and depict the results in Table 2. For these Likert scale questions, participants chose between very good and very poor.

1. Playing SonicTaiji improves my experiences:
2. Does this match your expectation of what Taiji sounds like?
3. What do you think of SonicTaiji?

Table2. Subjective Questions Results

	Very Good	Good	Neutral	Poor	Very Poor
1	7	2	0	0	0
2	6	2	1	0	0
3	9	0	0	0	0

The results in Table 2 illustrate favorable results for SonicTaiji in the 'Experience' and 'Overall Opinion' questions. There was less agreement on what Taiji should sound like. When asked which mode they preferred, all subjects preferred the natural sound mode over the FM mode. This is perhaps because users would prefer familiar sounds over synthetic sounds while using SonicTaiji. When asked which style SonicTaiji best matches the sound to, subjects selected "Playing the Lute" and "Wave Hands like Clouds," perhaps due to the connections between the styles' names and the sound design.

6. CONCLUSION AND FUTURE WORKS

In this paper we presented a mobile application, *SonicTaiji*. Based on user evaluations, it is promising to combine the concept of Taiji gesture control synthesis and meditation music. The next step of this project is to experiment with a wider range of synthesis techniques and samples, and to evaluate more Taiji users for stronger objective and subjective user results.

7. REFERENCES

- [1] M.H. Nguyen, A. Kruse. "The effects of Tai Chi training on physical fitness, perceived health, and blood pressure in elderly Vietnamese," *Open Access Journal of Sports Medicine*, no 3, pp. 7-16, March, 2012.
- [2] P. Brinkmann, *Making Musical Apps. Real-time audio synthesis on Android and ios.* USA, O'Reilly Media, 2012.
- [3] D. Lane, "Music therapy: A gift beyond measure," *Oncology Nursing Forum*, 1992, 19, pp 863-837.
- [4] I. I. Bukvic, and M. Komelski, "Strategies for Structured *Ork Performance Choreography: Integrating Taiji Martial Arts into L2Ork Repertoire." *In Proc. of the 1st Symposium on Laptop Ensembles & Orchestras*, USA, 2012.
- [5] J, Jakovich and K. Beilharz, "Sonic Tai Chi: Auditor Gestures in Reactive Soundspaces" in Pisan, Y. in *Proc. of the 2nd Australasian Conference on Interactive Entertainment*, Sydney, 2005.