Reimagining “Talempong” as a Digital Musical Interface

Muhammad Ikhsan Assaat[1], Kia Ng[2]

ICSRiM —University of Leeds,
[1] School of Music and [2] School of Computing,
Leeds LS2 9JT, U.K.
[1] ikhsan.assaat@gmail.com,[2] k.c.ng@leeds.ac.uk

Abstract. This paper describes the design and development of a mobile instrument interface inspired by an Indonesian percussion called ‘Talempong’. The digital ‘talempong’ is implemented as an iPhone application exploring its movement sensors to stimulate physical playing gesture of the ‘Talempong’; the mobile phone acts as the stick to play the instrument. Using its iPhone motions sensors, the application use an algorithm to detect a hit in real-time. Once detected, the hit is extracted and mapped to synthesise a ‘talempong’ sound according to the playing gesture. Additionally, visual and haptic feedback are provided using visual cues and device vibration.

Keywords: Talempong, mobile music, iPhone, motion analysis, sensor

1 Introduction

‘Talempong’ is an Indonesian percussion which is a very important symbol/identity of the West Sumatran people. It is used in large social events such as wedding and other ceremonies, and a key musical instrument to accompany traditional dance and theatre show. The instrument consists of a set of small knobbed gongs, each produces a different pitch. To play the instrument, the player hold one or two gongs with one hand, and the other hand hit the talempong with a stick/beater.

The word ‘talempong' applies to the instrument and the ensemble. A talempong ensemble usually consists of three players. With typically two gongs per player, the ensemble can produce around six notes. Talempong’s material produces a short sustain sound, which requires its players to play fast interlocking patterns. The fast and dynamic nature in talempong playing makes it challenging to simulate.

Fig. 1. Playing two notes on a talempong

2 Related Works

The advancement of iOS devices attracts many researchers and artists to explore mobile music with iPhone due mainly to its processing power and integrated sensors. There are many mobile music developments that can be related to this project including : The Ocarina (Wang 2009), Zoozbeat (Weinberg, Beck and Godfrey 2009) and Sound Bounce (Dahl and Wang 2010). All of these projects use iPhone's motion sensors to control the sound output. Additionally, several frameworks developments have helped the development of this project, making the development more rapid. For example, Cook's Synthesis Toolkit (STK) (Cook and Scavone 1999) has been used to to process audio signal and synthesise sounds .

In the similar context as Tzanetakis (2007), this project also contributes as a 'computational ethnomusicology'. This project offers a simple but useful function to capture and analyse the performance gesture. Related works in this aspects for other Asian musical instruments include: Indian hyperinstruments (Kapur 2004) and sensor-enabled taiko drum sticks, Aobachi (Young and Fujinaga 2004).

There have also been a range of works involving the application of technologies to musical instruments. Focusing on Indonesian musical instruments, examples include: Elektrika (Pardue 2011), Gamelan Sampul (Wiriadjaja 2013), Gamelatron (Kuffner 2014) and E-Suling (Erskine 2011).

3 Design

3.1 Requirements

To recreate the playing experience, we use the phone body as the stick for playing a 'virtual' talempong. The player would produce a sound by making motion of hitting the talempong gong with an iPhone without the real physical gongs. Based on this application scenario, we devised requirements for the application which lead to the design and development of the system.

3.2 Data Analysis

We conducted a feasibility experimentation to understand the sensors data of user motion when they hit a 'virtual' talempong using an iPhone. Participants were asked to make a motion of hitting talempong using their right hands, to play along with prerecorded audio of musical patterns. This task was influenced by Dahl's experiment on hit detection of air drumming gestures (Dahl 2014). Fourteen participants were asked to play three patterns, each with two different speed. Each patterns has its own prerecorded audio that guided participants' playing.. This experiment uses a cutout cardboard to provide visualisation of hit areas.

3.3 Hit Detection

To design the hit detection algorithm, we studied data captured with all the different motion sensors including accelerators and others with synchronised audio recorded with the contacts made when the iPhone touch the hit-surface (just for the experimentation). Various peak detection algorithms were tested to study their accuracy and performance. We measure the performance by the average distance (in time) between the perceived hits and the audio onsets. Perceived hit is the local maxima (peak) from the motion data. Audio onset is acquired from reading the audio file's waveform.

The result of these simple experiments found that the rotation rate on Z axis of the accelerometer sensor produces the best result. Rotation on Z axis can be explained with the right hand rule; if tip of the thumb points toward positive Z, a positive rotation is one toward the tips of the other four.[1] Rotation rate on z axis produces the best result because the majority of participant move the iPhone in similar fashion when they intended to make the hit motion. Although no clear instruction were purposely given, generally participants made similar hammering-like motion on its side of the iPhone (with the screen facing upward to the user).

Using rotation rate of Z axis of accelerometer sensor, the system receives peaks that are not related to a hit. We use a threshold, *t*, to eliminate noise that can mislead the detection. To configure the value of the threshold, we compute mean and standard deviation of the data using a sequence of recordings using several different phones. From the data, we set threshold with 2.5 times of standard deviation. Figure 2 show the good signal to noise ratio of the Z axis in contrast to the other data and their relation to the audio onset.

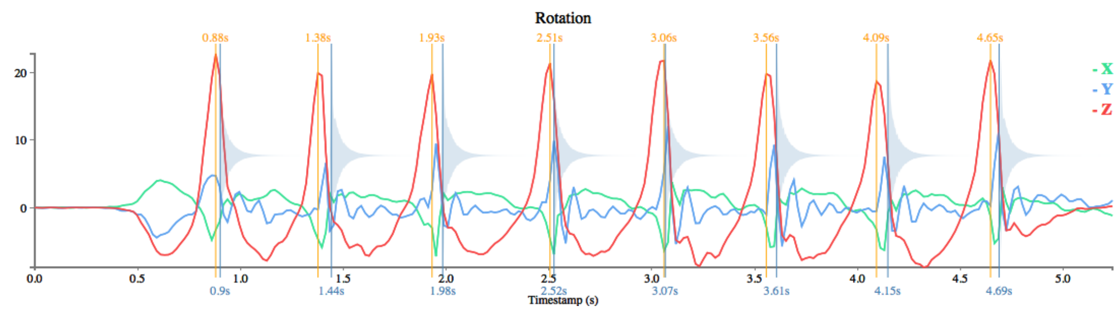

Fig. 2. Graph for rotation rate with audio onset

3.4 Angle Detection

When detecting a hit, the system need to choose which note was hit, i.e. was it the top gong or the lower gong. To classify which area was hit, the system opts for a simplistic approach using the value of the device's gravity sensor. We divide the hit orientation by 45° segments. By comparing the angle, we can roughly separate the hit angle into two areas: Q1 with the orientation angle < 45°, and Q2 with the orientation angle >= 45° Orientation within Q1 suggests hit on the lower gong and Q2 suggests hit on the upper gong.

3.5 User Interaction Design

The device's orientation will mapped to which note to play; the low note or high note. Besides the hit detection and classification, other sensors values are mapped onto additional musical characteristics. For example, the value of rotation rate on Z axis determines the loudness of the sound. All these sensor data and analysis are translate into synthesis parameters to synthesise appropriate resulted sound in relation to the player's motion.

Although user may not be able to see the screen closely, visual feedback still be provided through the device's screen. The screen is useful to show clear visual cues and animations. Another option for providing feedback is by vibrating the device. Figure 3 shows the different kind of interactions that the system provide.

[1] https://developer.apple.com/library/ios/documentation/EventHandling/Conceptual/EventHandlingiPhoneOS/motion_event_basics/motion_event_basics.html#//apple_ref/doc/uid/TP40009541-CH6-SW22

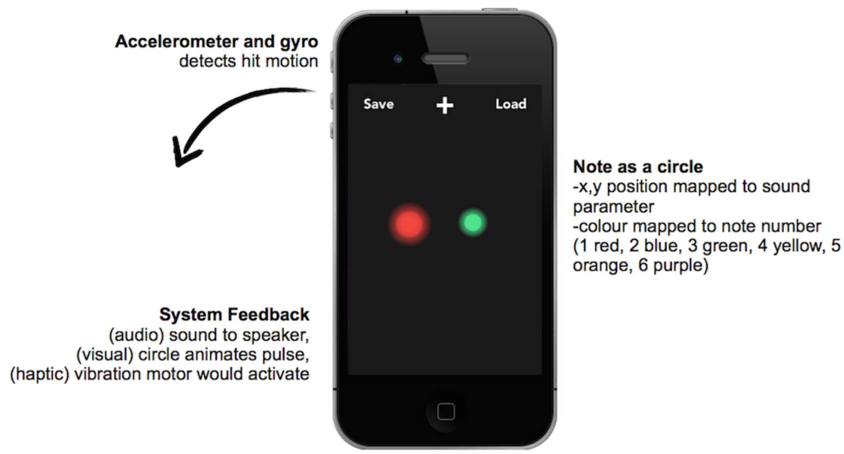

Fig. 3. The instrument's user interaction design

3.6 Extending Talempong

Being a digital instrument, the system could offers different ways to control and manipulate the sound synthesis engine by changing parameters and applying effects. A note would be presented as a node in screen, which its position can be mapped to sound parameters. Users could drag and drop the two notes in the screen to shape the sound of the notes. We tried to map x and y value to stick hardness and modulation frequency respectively. The mapping could easily be changed to any other sound parameter. The system also offers five sets of frequency ranges, with the lowest set is one octave below and the highest set is one octave above the normal set of frequency.

4 Development

4.1 System Architecture

The system is divided into three main parts; user input, data processing and system output. The flow starts from getting the data stream of user's motion from the built-in motion sensors of the iPhone. Multi-touch input is used to provide an additional controls to configure the final sound synthesis. Every time the system receives new data, it applies the algorithm to check if there is a hit. When the algorithm detects one, the system will pass the information to the sound synthesis engine for producing the sound. All the parameters are also used for visualisation.

The system outputs three different types of feedback. Sound synthesis produces the sound of talempong through audio speaker (or plugged headphone). Graphics renderer renders and animates shapes to visualise the sound on the device screen. Device also vibrates based on the loudness of the sound being played. Figure 4 illustrates an overall architecture of the system.

4.2 User Interaction

The system support various way of interaction. See http://www.ikhsan.me/digitaltalempong for a step-by-step demonstration (with video) of user interaction features and designs. One talempong note is presented visually as a circle shape with different colours for each note. The note's position is mapped to two sound parameters, which user can drag and drop to move the notes around the screen. The system chooses which talempong note to play using the device's orientation towards the ground. The system extends the range of the base frequencies, which is obtained from the talempong of '*Talempong Pacik Ateh Guguak*' (Darlenis 2006), with the lowest set is one octave below and the highest set is one octave above. Each hit is presented as a pulsing animation that radiates from the corresponding note according to its amplitude.

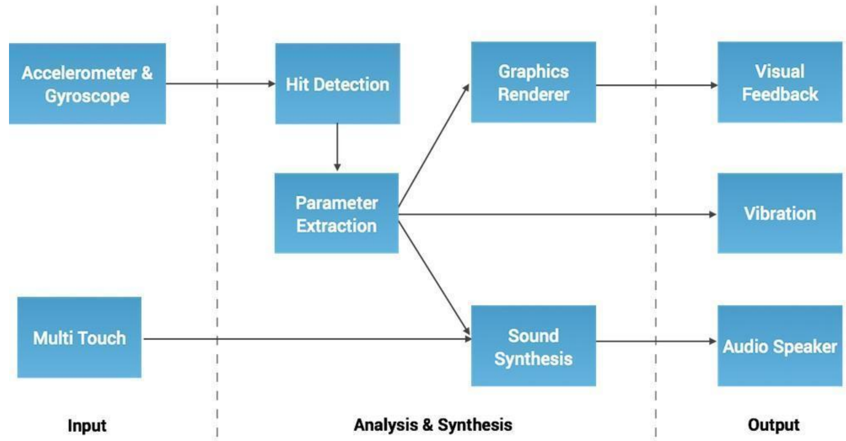

Fig.4. System architecture design

5 Evaluation

We measure the performance of the hit detection in slow and fast tempo (90 bpm and 240 bpm). Both tempo represent the tempo range of talempong music. From ten evaluations, the system detects 320 out of 320 hits. Evaluation has also been carried out to measure the accuracy of note classification, i.e. which gong was hit. With 480 hits, the current prototype was able to classify the hits at 99.2%, with 98.75% for the top gong and 99.58% for the lower gong.

Qualitative evaluation was conducted using questionnaires with a small group of participants. The majority (85%) of the participants believe that the interface is easy to use and responsive. For almost half (43%) of the participants, the system's feedback was helping to them and they can use the interface to learn or practise playing the musical instrument. The evaluators commented on some inconsistencies on hit detection for very fast tempo.

Several evaluators suggested that it will be more fun to learn if the users have more precise learning objectives rather than a totally unconstrained interface. Other suggestions include: (i) to offer brief history and tutorial on how to play the real instrument inside the application; (ii) the system could offer social interaction features that allow multiple players collaborate in person or remotely. Recording and sharing to social media channels was mentioned by some of the participants.

6 Conclusion and Future Work

This project shown that available commercial devices could be transformed into an expressive digital traditional musical instrument. We received feedback that indicates appreciation of the system capacity to offer a new and fresh presentation of the traditional percussion performance. The evaluators believe that the approach enables talempong to be more accessible and appealing to younger generation.

With the current prototype, there are many exciting aspects to further expands and to add new functionalities. At the time of writing, we are investigating the use of such interactive system to provide technology-enhanced learning for musical tempo and rhythmical patterns which is one of the key aspects of musical learning. We plan to use machine learning and clustering techniques to classify rhythmical pattern of talempong, not only for recording, classification and archiving, but also to create an interactive system that can "improvise", interact and perform with the musicians/learners, accompanying performance (such as in ensemble playing) or to support self-learning.

References

Cook, Perry R and Gary P Scavone. "The Synthesis ToolKit (STK)". *Proceedings of the International Computer Music Conference* (1999): 1-4. Accessed September 18, 2014. https://ccrma.stanford.edu/software/stk/papers/stkicmc99.pdf

Dahl, Luke. "Triggering Sounds From Discrete Air Gestures : What Movement Feature Has the Best Timing?". *Proceedings of the International Conference on New Interfaces for Musical Expression* (2014): 201-206. Accessed September 19, 2014. http://nime2014.org/proceedings/papers/514_paper.pdf

Dahl, Luke and Ge Wang. "Sound Bounce: Physical Metaphors in Designing Mobile Music Performance". *Proceedings of the International Conference on New Interfaces for Musical Expression* (2010): 178-181. Accessed September 18, 2014. http://www.nime.org/proceedings/2010/nime2010_178.pdf

Erskine, Jason and Ajay Kapur. "E-Suling: Extended Techniques for Indonesian Performance". *Australasian Computer Music Conference* (2011). Accessed September 19, 2014.

Kapur, Ajay et al. "Digitizing North Indian Performance". *Proceedings of the International Computer Music Conference* (2004). Accessed September 20, 2014. http://www.karmetik.com/sites/default/files/publications/2004_icmc_dnip.pdf

Kuffner, Taylor. "Gamelatron Project : The Marriage of Indonesian Sonic and Ritual Tradition with Modern Robotics". Accessed September 20, 2014. http://gamelatron.com

Pardue, Laurel S et al. "Gamelan Elektrika : An Electronic Balinese Gamelan". *Proceedings of the International Conference on New Interfaces for Musical Expression* (2011): 18-23. Accessed September 20, 2014. http://www.nime.org/proceedings/2011/nime2011_018.pdf

Tzanetakis, George et al. "Computational Ethnomusicology". *Journal of Interdisciplinary Music Studies* (2007): 1-24.

Wang, Ge. "Designing Smule's Ocarina : The iPhone's Magic Flute". *Proceedings of the International Conference on New Interfaces for Musical Expression* (2009): 303-307. Accessed September 20, 2014. http://www.nime.org/proceedings/2009/nime2009_303.pdf

Weinberg, Gil, Andrew Beck and Mark Godfrey. "ZooZBeat : A Gesture-Based Mobile Music Studio". *Proceedings of the International Conference on New Interfaces for Musical Expression* (2009): 312-315. Accessed September 19, 2014. http://www.nime.org/proceedings/2009/nime2009_312.pdf

Wiriadjaja, Antonius O. "Gamelan Sampul : Laptop Sleeve Gamelan". *Proceedings of the International Conference on New Interfaces for Musical Expression* (2013): 6-7. Accessed September 18, 2014. http://aimlab.kaist.ac.kr/nime2013/program/papers/day3/demo3/246/246_Paper.pdf

Young, Diana and Ichiro Fujinaga. "AoBachi : A New Interface for Japanese Drumming". *Proceedings of the International Conference on New Interfaces for Musical Expression* (2004): 23-26. Accessed September 18, 2014. http://www.nime.org/proceedings/2004/nime2004_023.pdf