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Virtual Thai Xylophone Game Development

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Abstract: This paper proposes the prototype of a virtual Thai xylophone game that is designed and developed for entertainment together with skill practicing of playing this instrument on an Android-based mobile phone. The game works with a motion tracking device attached to a beater and a mockup rail of a Thai xylophone bar. The motion tracking device uses ESP32, IMU 6 degrees of freedom and a 3.3V LI-PO battery, which detects the hitting state and acceleration. The motion tracking device communicates with the game via Bluetooth low energy. The mockup rail image is used to determine the beater position on 7 Thai xylophone bars. The four blue circles in each corner of the image are used to determine the boundary of the Thai xylophone rail by using the front camera of the mobile phone mounted with a 45 degree mirror and image processing techniques to detect the beater position to determine the note. The game is developed with Unity3D. The process of developing the game system involves research data, system design, the accuracy in detecting position and hitting, and game development. The game is then tested and evaluated with 6 users in three aspects, performance, appearance, and usability. The results showed that all parts of this game were evaluated at a moderate level.

Keywords: virtual musical instrument, Thai xylophone, motion tracking, image processing

A Ranad is a traditional Thai xylophone, which is in the percussion group of Thai musical instruments. It involves using two beaters to hit the wooden bars on the rail as shown in figure 1. A novice player cannot play this Thai musical instrument perfectly without the guidance of an expert. Nowadays, the number of players of Thai musical instruments has decreased because of the image of the instrument for the younger generation and the price of the instrument. This research proposes a new way to play Ranad for the younger generation by using a game on a mobile phone with a motion tracking device attached to the beater to capture the hitting state and acceleration, combined with the image processing capabilities of the front camera. The goal of this research is to encourage young people to enjoy playing the game and to acquire skills in playing the Ranad.

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Figure 1 Thai xylophone, Ranad (Tramote 1973)

LITERATURE REVIEW

There are many researches using virtual environments to teach skills (Bergamasco, Bardy, and Gopher 2012). For example, a surgeon needs high levels of surgical skill to minimize the risk to the patient (Cohen et al. 2013); an athlete can enhance their sports skills by analyzing movement (Bideau et al. 2010) and a student can learn how to play the Ranad using a virtual environment (Laddawan Meeanan et al. 2012). A motion tracking system is used to measure the position and movement of an object or body. A tracking system can use vision, such as Microsoft Kinect, to track the motion of hands in a virtual electronic experiment system (Hongjian Liao and Zhe Qu 2013) and the Leap Motion to track human fingers when using a virtual instrument (Hsu, Shih, and Chiang 2014). In 2014, Penelle and Debeir proposed the data fusion of Microsoft Kinect and Leap Motion to improve the accuracy of hand tracking (Penelle and Debeir 2014). A tracking system using an electronic device is an inertial measure unit (IMU) measuring the values of linear acceleration with an accelerometer and angular speed with a gyroscope that can be used to capture the upper limb motion with a real-time tracking system (Anuar, Sahari, and Yue 2016). Areodrums and Freedrum are two commercialized virtual drum instruments. Areodrum uses a visual tracking system while Freedrum uses an electronic device. Both virtual drums can be played in the air. Freedrum is easier to use than Areodrum, which requires the user to set up the system and the environment (Yannick 2018).

SYSTEM OVERVIEW

The overview of the system consists of two parts as shown in figure 2. The first part is the motion tracking system using the ESP32 (TTGO T8) as the microcontroller unit to capture the hitting state and acceleration value by using the GY-521 (MPU6050) as the inertial measure unit connected to a 3.3V LI-PO battery. The second part is the Android-based mobile phone for game applications using the front camera to capture the hitting position by using image processing techniques for beater detection.

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The two parts communicate wirelessly using Bluetooth low energy. The first part sends the data on the hitting signal and level to the second part, which calculates the note by detecting the beater on bar area, which generates the sound.

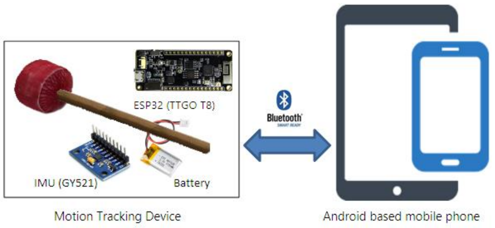

Figure 2 System overview

MOTION TRACKING OF BEATER

The motion tracking device captures the hitting state and acceleration value by transforming the linear acceleration and angular speed into the gravitational frame. Then, the acceleration of the z-axis is recorded and plotted for one beater hitting as shown in figure 3. From the graph, the hitting occurs when the acceleration value is quickly decreasing to less than -10000, and then increasing to 1000 in less than 300 milliseconds. After that, the acceleration value will decrease to zero. If this scenario occurs, the hitting state will be sent to the game via Bluetooth low energy.

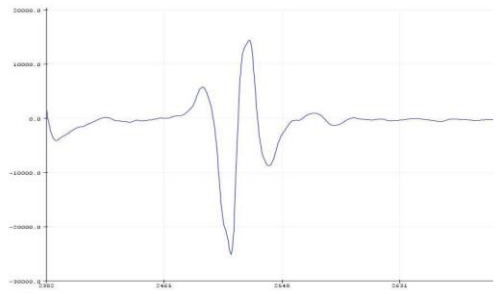

Figure 3 A hitting of beater

BEATER POSITION DETECTION

The position of the beater is detected by using image processing techniques from the mobile phone's front camera. The 45 degree mirror is mounted on the front camera to reflect the mockup rail of the Ranad bars with four blue circles in each corner as shown in figure 4. The mockup rail of the Ranad bar pictured by the camera is not a rectangle because of the position of the mobile phone. Then, the warp perspective is used to transform it back to a rectangular shape (figure 5) by detecting the blue circles in each corner. Next, the beater position is determined by using color detection of the beater head from the HSV color space (figure 6) and the position of the beater on the Ranad bar is calculated, The Ranad bar is divided into 7 bars for the notes Do, Re, Mi, Fa, Sol, La, and Te, respectively.

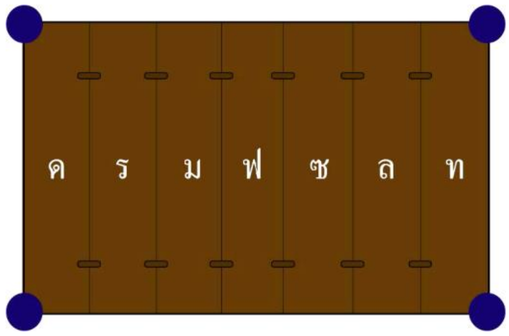

Figure 4 The mockup rail of the Ranad bars

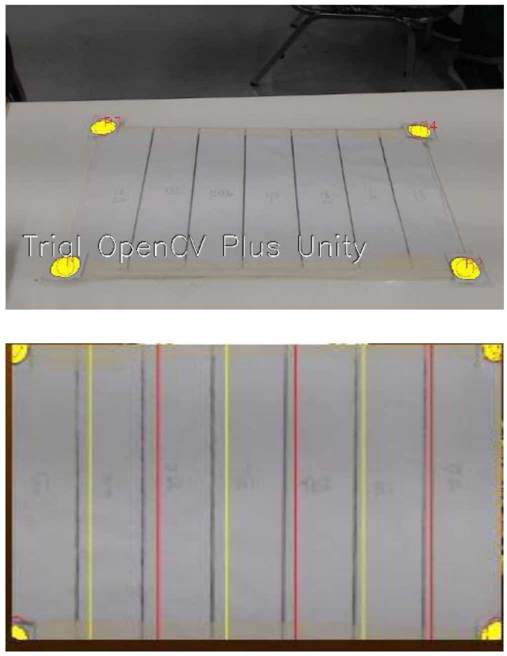

Figure 5 The picture from the front camera (upper) and the picture after the warp perspective (below)

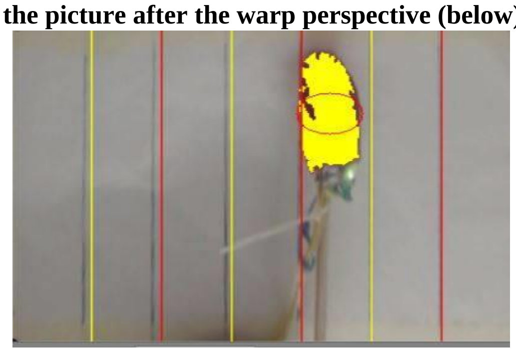

Figure 6 Beater position detection

RANAD GAME DEVELOPMENT

The Ranad game was developed by using Unity3D. The game consists of 2 modes which are the blink blink mode and the Ranad hero mode as shown in figure 7. The game setup involves a tripod to hold the mobile phone mounted with 45 degree mirror on the front camera as shown in the upper right of figure 8. The beater is attached to the motion tracking device as shown in the lower right of figure 8. When the game application starts, the motion tracking device is connected to the mobile phone with Bluetooth.

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The game will then start when the player selects the game mode. In each game mode, the hitting data will be sent to the game. If the beater is in a hitting state, the beater position is calculated from the front camera video.

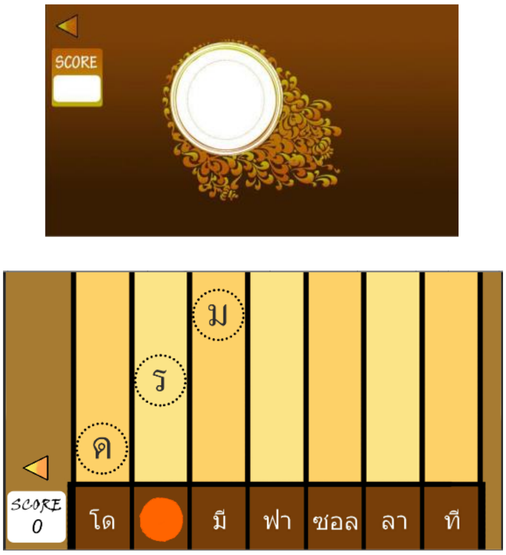

Figure 7 Ranad game modes, blink blink (upper) and Ranad hero (lower)

EXPERIMENTAL RESULTS AND DISCUSSION

The experiment to verify the accuracy of the beater state and position is tested. The first experiment involves 10 hits on each bar. The results are shown in Table 1. Errors were detected for the notes Re, Mi, Sol, and La due to the viewing angle of the camera and the distance between the beater and the camera.

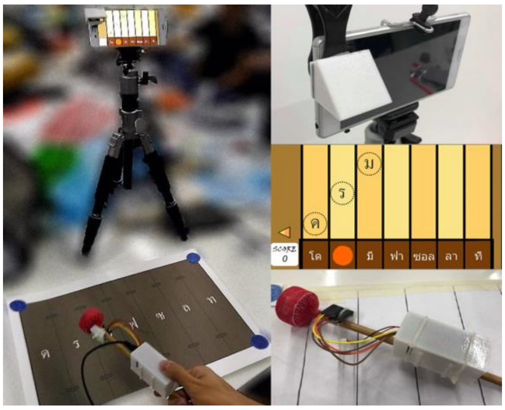

Figure 8 The system setup

These affect the beater position detection, which will be reduced by using area-based decision techniques and better beater calibration.

Table 1 Beater hits on each note

	Do	Re	Mi	Fa	Sol	La	Te
#Hit	10	7	5	10	5	8	10

The second experiment aimed to find the best area on the bar (upper, middle, lower) with varied distance (10, 20, 30) in centimeters from the beater. Each test was conducted 10 times. The results (figure 9) showed that a distance from the beater to the bar of about 10 centimeters gets the highest level of accuracy. If the beater is in the middle of the bar, it will get a longer hitting time. The notes Do, Fa, and Te got more hitting time as in the first experiment.

The virtual Ranad game system has been tested by 6 participants in terms of performance, appearance, and usability. The results of all parts of this game system were evaluated to be at a moderate level.

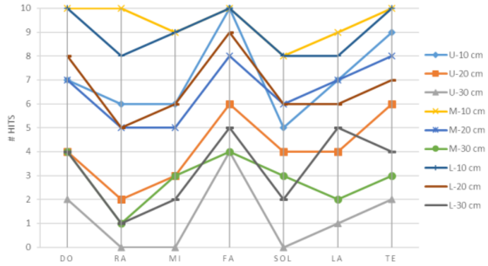

Figure 9 The second experiment result

CONCLUSION

In this research, a virtual Ranad game was developed for users who want to play the Ranad for fun and to practice the beater movement skills without a real Ranad instrument. A motion tracking device is attached to the beater to determine the hitting state and acceleration and the beater position from the detection of the beater head using image processing techniques. For future research, there are two main extensions of this research. The first area is using a virtual reality viewer, which will increase the user experience to be more realistic. The second area is to expand the motion tracking device and application to MIDI standard, which will make the motion tracking device and software adjustable to fit other instruments and software.

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REFERENCES

1. Anuar, Adzly, Khairul Salleh Mohamed Sahari, and Ewe Chern Yue. 2016. "Development of a Low Cost Upper Limb Motion Tracking System with Real-Time Visual Output." In *2016 IEEE International Symposium on Robotics and Intelligent Sensors (IRIS)*, IEEE, 146–50.
2. Bergamasco, Massmo, Benoit Bardy, and Daniel Gopher. 2012. "Skill Training in Multimodal Virtual Environments."
3. Bideau, Benoît et al. 2010. "Using Virtual Reality to Analyze Sports Performance." *IEEE Computer Graphics and Applications* 30(2): 14–21.
4. Cohen, Alan R et al. 2013. "Virtual Reality Simulation: Basic Concepts and Use in Endoscopic Neurosurgery Training." *Child's nervous system: ChNS: official journal of the International Society for Pediatric Neurosurgery* 29(8): 1235–44.
5. Hongjian Liao, and Zhe Qu. 2013. "Virtual Experiment System for Electrician Training Based on Kinect and Unity3D." In *Proceedings 2013 International Conference on Mechatronic Sciences, Electric Engineering and Computer (MEC)*, IEEE, 2659–62.
6. Hsu, Mu Hsen, Timothy K. Shih, and Jen Shiun Chiang. 2014. "Real-Time Finger Tracking for Virtual Instruments." In *2014 7th International Conference on Ubi-Media Computing and Workshops*, IEEE, 133–38.

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7. Laddawan Meeanan et al. 2012. "The Edutainment of Virtual Music Instrument for Thai Xylophone (Ranad-Ek)." In *2012 International Conference for Internet Technology and Secured Transactions*, London, UK, 546–47.
8. Penelle, Benoît, and Olivier Debeir. 2014. "Multi-Sensor Data Fusion for Hand Tracking Using Kinect and Leap Motion." In *Proceedings of the 2014 Virtual Reality International Conference on - VRIC '14*, New York, New York, USA: ACM Press, 1–7.
9. Tramote, Montri. 1973. "Thai Musical Instrument." *Thai Junior Encyclopedia By Royal Command of H.M. the King*: 245.
10. Yannick. 2018. "Freedrum Review - Is This Virtual Drum Kit Any Good?" http://www.kickstartyourdrumming.com/freedrum-review/ (July 23, 2018).

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