The Application of Binaural System on Virtual Reality Technology Through the Animation of Wayang Kulit Yogyakarta Performance

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Abstract. Binaural system is an audio technology which relatively easy to apply these days. This was due to the growth in technology developments of the audio recording system. The application of this system is not well known in Indonesia. This was aligned with public assumption where Wayang Kulit performance are one of many unappreciated forms of arts in Indonesia. The main problem that occurred is that whether the binaural system conjoined with the Virtual Reality (VR) System can make the public more appreciate the art form of Indonesian Wayang Kulit. By using the theory of perception conjoin with the binaural technology, it can be assumed that the audience can have a new experience from the performance through the VR thus elevating their appreciation for the art itself. This research will be divided into three stages. The first stage focused on the application of the binaural system on Wayang Kulit Animation through VR system. The second stage will focus on the product assessment whether it can elevate the appreciation of the audience for the art itself. The third stage will focus on applying the binaural system on other Indonesian art form. This year, the research will begin at the first stage.

Keywords. Binaural, virtual, wayang, audio

1. Introduction

The development of technology has been very rapid, especially in the field of entertainment. One of the technologies that is currently being widely used is Virtual Reality (VR). VR is a technology that uses Virtual Reality headset which is sometimes a combination of physical environment or props, to produce images, sounds, with other sensations that simulate the physical presence of the user in a virtual environment or imagination. Nowadays, VR technology is used as a supporting tool in research in various scientific fields. Some examples of sciences that use VR are medicine, civil engineering, design, and architecture [1].

The audio system used in VR technology is called binaural recording. Binaural is a method of recording sound using two microphones. The microphone is arranged in such a way as to create a stereo 3D sound sensation for the listener so that the listener feels like they are in another location. Binaural systems are still very rarely applied to video media due to lack of knowledge to record sound using binaural systems.

The term binaural was introduced by Alison in 1861 to explain that two ears are involved in human hearing [5]. The term is often used until 1970 for techniques where the recording or reproduction of two signals is intended for two ears. Indirectly, systems that produce two-channel sound are called binaural as well as stereophonic. Bell is arguably the first person to combine the two terms at the time he wrote about the "Stereophonic Phenomena of Binaural Audition" [6]. One example of an equipment capable to record Binaural audio is a Dummy Head.

Dummy head is a replica model of a human head where in both ears there is a microphone that will capture the sound signal. If the signal is played back through a headphone, it will sound the same as if we are in the position of the dummy head [7].

Figure 1. Neumann KU 100 (Source: https://en-de.neumann.com/ku-100)

Binaural recording has a natural sensation of 3D sound because it uses technology from various scientific fields. Some of these scientific fields are acoustic physics, psychoacoustics, and auditory neurophysiology. Nowadays, the tool used does not have to be a dummy head. An earphone with a microphone inside can be used by a recordist to perform binaural recordings. Merging the Roland CS10-EM with a Handy Recorder (H4N Zoom) can record and produce an audio that recreates sound as if we hear the sound through someone's ears.

Figure 2. Roland CS10-EM (left) dan Zoom H4N (right) (Source: https://www.zoom-na.com)

Recording in this way replicates important elements of acoustic physics including interaural intensity difference (IID), interaural time difference (ITD) and head-related transfer function (HRTF) [8]. The merging of these elements results in a recording that provides a sound quality resembling 3D audio. The reason was each ear receives a different amplitude and spectrum because one of the ears is covered by the head and the two ears are separated by distance and these interaural differences vary with the location of the sound source around the listener's head [7]

Wayang is one of the arts in Indonesia and spread in almost all regions of Indonesia with the characteristic appearance of different puppets [2]. Wayang performance is a performance where the core

story of wayang talks about the heroism of the characters who are good character facing and defeating the evil character. Wayang culture has a very long history, from generation to generation, which shows that wayang culture has become a living part of the Indonesian nation, especially java. "Wayang is a traditional literature that meets the qualifications of masterpiece works, literary works and or adiluhung culture" [3].

In the puppet show, there is one scene called goro-goro where Semar and his children, Petruk, Bagong, and Gareng present as an interspersed of the main story. Goro-goro is one of the popular parts of wayang performance where the puppeteer (the Dalang) uses this scene to comment on the current issue of Indonesian people's lives [4].

2. Sound Recording

Recording sounds of each instrument in the wayang show is intended to get all the sounds of the gamelan instrument where the results will be processed in the software and positioned according to the gamelan instrument visualization that has been made into an animation. The Roland CS-10EM will be used with the human ear-shaped 3D print by placing the earphones on the 3D Print ear to record the Binaural audio.

Figure 3. Human ear 3D print (Source: Personal documentation)

The recording stage of the puppet show will be done in several stages:

1. Planning stage of the division for the microphone placement as well as the decision of microphone type
2. Microphone positioning stage
3. Recording stage of sounds from wayang kulit performance.

At the planning stage of the division for the microphone placement, each gamelan instrument used will be mapped according to the concept of the wayang's performance stage. Setting the number and type of microphones to be used for each instrument will be done after the mapping data is obtained.

Mapping is done by referring to the concept of the stage used in the wayang kulit performance. The puppet shows focuses on the goro-goro¬ stage where the story is about Arjuna's journey in finding his identity where in the end, Arjuna can defeat the symbol of evil. In this goro-goro stage, there is also Petruk character who talks about the true character of an authority in terms of personal, behavior, and attitude that is usually raised from the issue of Indonesian society today.

The microphone used in this performance is a dynamic microphone type because the recording is done in an open space. The performance used 32 microphones with the following divisions:

No.	Nama Instrumen	Jumlah Instrumen
1	Kenong	2
2	Gender	2
3	Slenthem	2
4	Kendang	2
5	Gong	1
6	Bonang	4
7	Suling	1
8	Rebab	1
9	Gender	2
10	Siter	1
11	Gambang	2
12	Kempul	2
13	Demung	1
14	Suling	1
15	Trumpet	1
16	Saron	1
17	Peking	1
18	Dalang	1
19	Sinden	3
20	Keprak	1

Figure 4. List of Gamelan Instruments (Source: Personal documentation)

The mapped microphone is also set on the Behringer M32 mixing console for the balancing process that will be performed during the performance.

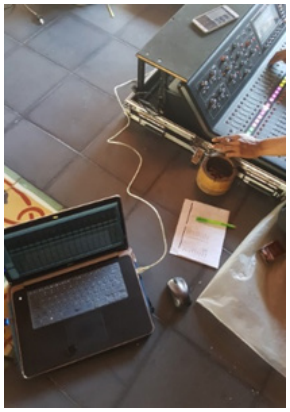

Figure 5. Instrument Mapping Process (Source: Personal documentation)

At the microphone positioning stage, each microphone will be adjusted according to the position of the gamelan instrument placement as well as the mapping data that has been created. Setting the position and distance between the microphone and the gamelan instrument will consider the recording location condition of the gamelan instrument.

The location used for recording the puppet show is Tembi Rumah Budaya located on Jl. Parangtritis Km 8.4, Tembi, Timbulharjo, Sewon, Bantul, Special Region of Yogyakarta. Tembi Rumah Budaya has two locations that can be used to hold wayang kulit performances, namely the main hall and a small amphitheater located at the back of Tembi Rumah Budaya.

Figure 6. Main Hall (left) Amphitheatre (right) (Source: Personal documentation)

Because the main hall of Tembi Rumah Budaya is right next to the main road and is expected to affect the sound quality of the recording results, the recording process will be held at the amphitheater at the back of Tembi Rumah Budaya.

This wayang kulit performance is intended for recording the sound of gamelan instruments along with the visual recording as a guide for the creation of animated performances of wayang kulit. The position placement of the instrument is adjusted slightly according to the position of the microphone so that the sound of an instrument is not recorded by the microphone intended for other instruments without compromising the traditional way of wayang performance.

Figure 7. Microphone and instrument position placement (Source: Personal documentation)

When setting the microphone position, the sound technician will perform a signal check and adjust the sound levels of the Dalang, the Sinden, and the entire instrument by adjusting the fader and equalizer (EQ) on the Behringer M32 mixing console.

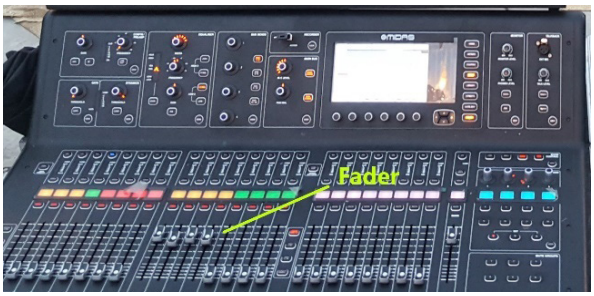

Figure 8. Fader Behringer M32 (Source: Personal documentation)

According to Bartlett (1999), faders are sound level settings obtained from each microphone while EQ is a tonal control setting where bass controls low frequencies (about 20 - 150 Hz), midbass control frequencies 150 - 500 Hz, midrange controls frequencies 500 – 5 kHz, and treble controls high frequencies (5 – 20 kHz) [7].

The binaural microphone (Roland CS10-EM) is connected to a handy recorder (Zoom H4N) by connecting the red cable from Roland CS10-EM to the external mic of the H4N Zoom. The binaural microphone is placed in the center position allowing the recording to be able to represent someone listening to the entire puppet show surrounded by each gamelan instrument assuming that the person is in a position facing the Dalang.

Figure 9. Binaural Microphone Position (Source: Personal documentation)

The sound recording stage of the wayang kulit performance is done at night (7 PM) to avoid unwanted sound artifacts and background noise in the area around the amphitheater.

Figure 10. Wayang Performance Recording Process (Source: Personal documentation)

The performance was recorded in four ways. The recording method is as follows:

1. Using stereo recording using a Universal Series Bus Flash drive (USB Flash disk) connected to the Behringer M32 mixing console.
2. Uses a binaural microphone connected to the H4N Zoom.
3. Uses H4N Zoom connected to the Behringer M32 mixing console via 2 output lines to be recorded stereo.
4. Using a laptop with Pro Tools 12 software connected to the Behringer M32 mixing console via a USB cable.

The recording process using Pro Tools 12 software begins with creating a new recording session and adding an audio track that will be used for recording each instrument as well as the Dalang and the Sinden. Each track is named after the instrument mapped to each previous microphone placement.

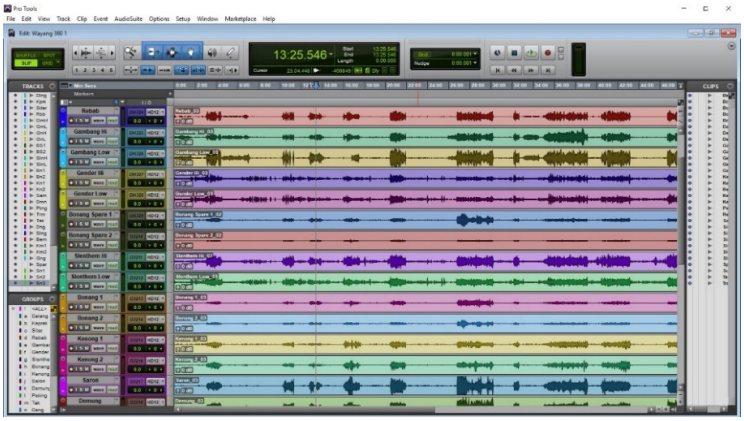

Figure 11. Pro Tools 12 Recording session (Source: Personal documentation)

3. Results and Discussions

To produce sound recordings with binaural systems, audio software is required that can perform binaural signal processes. In the audio software there are several additional elements called plugins. According to Bartlett (1999), the plugin is audio effect software installed on a computer where it is part of other programs used such as digital editing programs [7]. By using plugins dedicated specifically to binaural systems, one can generate binaural records. One of the binaural system plugins is Facebook 360 Spatial Workstation.

Figure 12. Facebook 360 Spatial Workstation (Source: http://www.avidblogs.com)

Through this plugin, each recorded sound can be adjusted according to the azimuth and the height angle following the visual reference of the finished animation generated. For example, if the position of the Sinden is in the position of the upper right 45 degrees corner with a height of 70 cm from the floor surface, then we only need to adjust the recording of the sound of the Sinden at that position and lock it using the visual references.

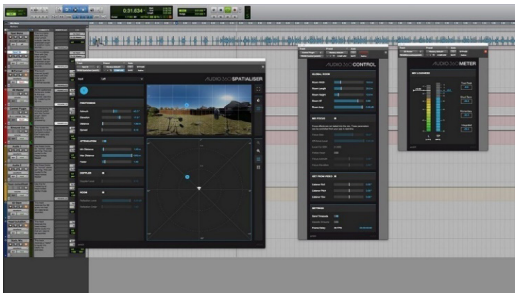

Figure 13. Sound Source Positioning Process (Source: http://www.avidblogs.com)

After the positioning process using the Facebook 360 Spatial Workstation plugin, the sound position settings that have been done can be put together using FB 360 Encoder into a file as shown in the workflow scheme of Facebook 360 Spatial Workstation.

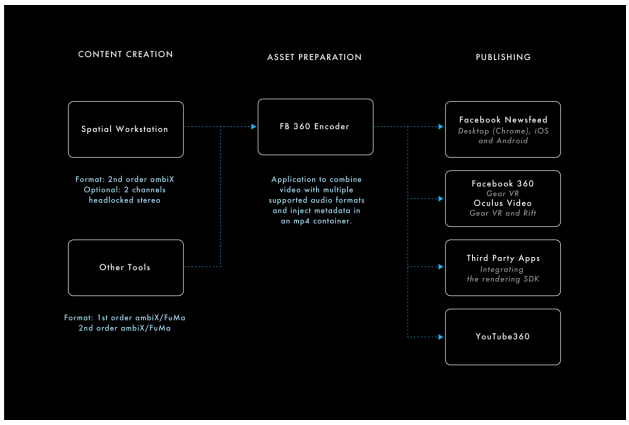

Figure 14. Facebook 360 Spatial Workstation Workflow (Source: http://www.avidblogs.com)

4. Conclusions

The use of binaural systems is still very rare in Indonesia while the potential in the use of such systems is very wide. Binaural systems with the incorporation of visual media such as animation can be done for the conservation of Indonesian culture such as wayang kulit.

The use of a positioning system in the Facebook 360 Spatial Workstation plugin on any sound element processed through audio software can provide recordings of 3D-like quality. This research has the assumption that people can have more appreciation for Indonesian culture with the use of the latest technology to introduce various Indonesian cultures nationally and internationally. It is not easy for one to directly feel the staging of an Indonesian culture because some Indonesian cultures are usually staged in a traditional way that requires complicated preparation and staging areas that are not easily achieved.

5. References

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