Virtual Gamelan Mobile Application

By

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CERTIFICATION OF APPROVAL

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Approved by,

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(AP Dr Dayang Rohaya binti Awang Rambli)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

September 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the reference and acknowledgements, and that the original work contained herein has not been undertaken or done by unspecified sources or persons.

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(AHMAD FARIS BIN AHMAD KHAIRI)

ABSTRACT

The Virtual Gamelan is a mobile application that simulates gamelan instruments, built for mobile devices using the Android operating system. The Virtual Gamelan attempts to recreate the “bonang” and the “saron”, which are instruments part of a normal gamelan ensemble, into digital form, suited for mobile use. The gamelan is a traditional musical ensemble originating from Java and Bali in Indonesia. It is an ancient art form which dates back to the 8^{th} century. The gamelan is known for its rich and blended sound signatures, and melodies that aspire tranquility and meditation. The art has garnered interests in all parts of the world, and also has a presence in Malaysia, having its own version called the Malay gamelan. The gamelan has been a part of a long historic culture, especially in Indonesia and Malaysia, as it has been always used in royal ceremonies, as well as formal events and occasions today. However, the popularity of the traditional art form is in decline, as new modern music genres appeals more to today’s generation. Making use of mobile technology, the Virtual Gamelan Mobile Application aims to revive the traditional gem to today’s modern world, in hope of exposing the gamelan more to the public.

ACKNOWLEDGEMENT

First and foremost, the writer would like to take this opportunity to express his greatest gratitude and appreciation to the project supervisor, Dr Dayang Rohaya binti Awang Rambli, who had continuously monitored his progress throughout the duration of the project. Her constructive comments, advices, and suggestions had guided the project towards its successful final outcome.

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Last but not least; the writer would also like to express his acknowledgement to every party involved, especially to the UTP Curriculum unit, for motivating traditional music and having such scarce traditional instruments ready for students, and the UTP Gamelan Group, "Sanggar Kirana" for inspiring the idea, as well as kindly assisting the progress of the project.

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ABBREVIATIONS AND NOMENCLATURES

UTP	Universiti Teknologi PETRONAS
OS	Operating System
SDK	Software Development Kit
IDE	Integrated Development Environment
JDT	Java Development Tools
SUS	System Usability Scale

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

The Gamelan is a traditional musical ensemble, largely originating from Indonesia. Mainly from the islands of Java and Bali, a gamelan ensemble would generally consist of a range of musical instruments such as metallophones, xylophones, kendang, gongs, bamboo flutes and bowed and plucked strings. Like an orchestra, the term 'Gamelan' represents the whole set of instruments, rather the sole players of the instruments. Hence, it is a set of instruments acting as a distinct entity, playing together as a unit.

The word gamelan comes from the Javanese word 'gamel', which means "to strike" or "to play". Following its name, most of the instruments in a gamelan ensemble are made of beaten metal and played with mallets. The sound of the Gamelan is known to be rich and soft. The smooth tones and the mash-up of rhythms could produce a tranquilizing mood, largely associating it with meditation music. Being a tradition with a long history, the gamelan still thrives as an art form today, and has increasingly garnered interests in all parts of the world.

In Malaysia, the gamelan was brought over to Pahang in 1811 from Riau-Lingga. The Malay gamelan differs from the Indonesian gamelan, as it has been refined through its music structure and the use of distinctive scales. Malay gamelan music is usually played during royal and formal occasions. Today, even though not prominent, there is still an interest to revive the music of the gamelan, and gamelan troupes have been growing and promoted especially in higher learning institutions.

1.2 Problem Statement

Gamelan is an orchestra instrument, which requires a large number of people for the music to be executed well. It is not a favourable instrument for people to own, due to a few factors explained below.

1.2.1 Immobility

Gamelan instruments are not preferable for people to own because of the instruments are being made of steel, iron, bronze or brass. Its large sheer size makes it heavy in weight, resulting in such a difficult item to carry around, especially by touring musicians.

1.2.2 Cost

The exotic material to make gamelan instruments contributes a lot to the gamelan's rich tone. However, the materials do not come in cheap and are made from hefty materials which are either steel, iron, bronze or brass. Prices are often hiked up due to the artistic complexity of the carvings on the wooden case of a gamelan instrument. A gamelan "peking", the smallest in a gamelan ensemble, could fetch up to at least RM300. Given its expensive price, to purchase one type of gamelan instrument on its own may be seen as worthless, due to its nature of being better suited to play with the other gamelan instruments together.

1.2.3 Inconveniency to practice

Due to the cost and immobility factors, Gamelan instruments are common for people to own. For Gamelan groups, their instruments are often placed and grouped together in a practice area. So whenever Gamelan players would like to practice, they would have to attend to the

practice room in order to rehearse. It is not mobile for them to easily bring around anywhere.

1.2.4 Declining popularity of the Gamelan

As we enter the modern era, traditions pass by and are slowly being forgotten. New innovations in musical instruments such as electric guitars or keyboard synthesizers has risen more in popularity among the younger generation. Popular modern music today has replaced valued music by past generations. The mass now are more exposed and influenced to music from the West, which makes them tend to forget about their own cultural roots. Without any initiatives to revive the gamelan back, the gamelan may be on their way to extinction.

1.3 Aim and Objectives of Study

The aim of this project is to study the essence of Gamelan music, and connecting it with modern technology. The objectives include:

1. To expose Gamelan music to the public and preserve the traditional art form, through the use of mobile technology.
2. To explore the use of multi-touch capability of mobile device interface for playing Gamelan instruments.
3. To emulate the Gamelan as a mobile application.
4. To evaluate user experience with the Virtual Gamelan.

1.4 Scope of Study

The Virtual Gamelan mobile application emphasizes on the realism of the Gamelan sound, and encompasses the history of the musical instrument which would help contribute to the complete understanding of its identity. Hence, it is

advisable to acquire and explore such an instrument, as well as gathering information from an expert specializing in the field.

Two instruments has been chosen to be featured in application: the Bonang and the Saron. The reason is because these two instruments are practically at the forefront of a Gamelan ensemble. The metallic bars and gongs signify the unique Gamelan sound.

The Virtual Gamelan targets users of all ages. The application is suitable for all ages as musical instruments do not specify at what age it should be played. Everyone from children to adults can use the application. It is a universal instrument where it does not necessarily targets a certain group of users. From musicians to casual mobile device users, the application may be used by all for whatever reason.

The application will be hosted on the Android Operating System. The Android is developed by Open Handset Alliance, led by Google Inc. It is a multi-channel and flexible operating system where it encompasses a wide range of mobile device brands such as Samsung, HTC or Acer.

Universiti Teknologi PETRONAS (UTP) has its set of gamelan instruments as part of its curriculum structure. Undergraduate students are required to undergo curriculum courses which include gamelan, as well as other cultural courses such as caklempong, basic dance and drama. The gamelan instruments are exclusively made for the university, shown in the wooden carvings of the UTP logo on the instruments. These instruments are often featured in performances by UTP's very own gamelan group, Ensemble in G. Ensemble in G has performed at numerous formal and non-formal events, establishing the group as being one of the most successful clubs in the university. Gamelan has unknowingly became the sound of the university itself, often having gamelan music being played at formal or corporate events. It also represents the university's stance of preserving the cultural values of Malaysia.

Having the gamelan instruments available in UTP, research was done here within the campus. Experienced tutors and gamelan players were reached easily for research purposes. Audio were recorded directly from these instruments to be used in the mobile application.

1.5 Feasibility of Project

The time allocated for the first half of the project was approximately four months. During these four months, the period was mostly reserved for research purposes. The research conducted involved reviewing and analyzing similar applications such as ‘GarageBand’ or ‘My Piano’, which are also touch-responsive musical applications. These similar applications set a benchmark for what is needed to be included and improved while implementing the project. Research papers was also analyzed to study the implementation of audio response to touch in mobile applications.

The second half of the project involved implementation, development and developer tests. Once the prototype was ready, the next phase involved user testing on the usability of the application. These results determined the success rate of the project. The period given until December 2012 which was roughly six months was ample for the project to complete.

CHAPTER 2

LITERATURE REVIEW

2.1 A Brief History and Background of the Gamelan

FIGURE 2.1. Wall carvings of a musical ensemble at Borobudur temple

The gamelan has been a native art form that has been mostly associated with the Hindu-Buddhist culture that dominated early Indonesia. The earliest image of the Gamelan was found in the wall carvings of the Borobudur temple in Central Java, which dates back to the 8th century. There were musical instruments such as bells, drums, bamboo flutes and stringed instruments in the carvings, suggesting it to be one of the ancient forms of the gamelan.

In the fourteenth century, people from the Middle-East introduced Islam throughout Indonesia, which brings to the fall of the Majapahit Empire. The signature gamelan melodies being heard today is a direct, almost pure, descendant of the music of the lost Majapahit period [2]. Even though the tools and identity of the gamelan is still preserved until today, the music has evolved and branched out to new styles. Generations of musicians have put their stamps over the genre, adding variation, compositions and new musical essence to the music.

Alternatively, the evolving gamelan that grows until today is the sum of diverse foreign influences. For example, bronze instruments mainly from South East Asia, drums from India, bowed strings from the Middle East, and even military styles from Europe contributes to the traditional music that could be heard in Java today.

FIGURE 2.2. Gamelan orchestra (1870-1891)

In Indonesia, the gamelan is normally performed accompanying dance, puppet performances, rituals, or ceremonies. Gamelan plays an important role in Indonesia' rich culture, as the sound shapes the identity of their heritage activities. For example, the gamelan's role in rituals is so important that there is a Javanese saying, "It is not official until the gong is hung" [3]. It is also customary to make sure visits by sultans are accompanied by a gamelan ensemble. In Bali, almost all religious rituals include a gamelan performance. Certain pieces are designated for starting and ending performances or ceremonies. When an end to a piece is played, the audience will know that an event is nearly finished and will begin to leave. Certain pieces are also believed to possess magic powers, and could be used to ward off evil spirits [3].

In Malaysia, the gamelan has its version in itself. The Malay gamelan still retains the same instruments as the Javanese or Balinese gamelan. However, it is distinctly different in how the music and melodies are played. Malay gamelan music sounds more simplistic, in that nearly all the instruments play the melodies, unlike the intricately locked parts of the Javanese gamelan.

The Malay gamelan is brought over to Pahang in 1811 from Riau-Lingga, and spread to Terengganu shortly afterwards through a royal marriage. The Malay gamelan is usually played at royal and formal occasions. This is customary since the reign of Sultan Ahmad of Pahang (1882-1914) and Sultan Sulaiman of Terengganu (1920-1942) [4]. Today, there is an interest to revive gamelan music throughout Malaysia and beyond, with efforts of promoting and writing gamelan music being pursued by local musicians, such as Ariff Ahmad and MonoLoque. Various local institutions such as Universiti Malaya and Universiti Teknologi PETRONAS, have set up their own gamelan ensembles, comprised of the university students themselves. The effort to promote the gamelan movement is still active in a hope to appeal more to today's youth.

FIGURE 2.3. Universiti Teknologi PETRONAS's gamelan group, 'Sanggar Kirana'

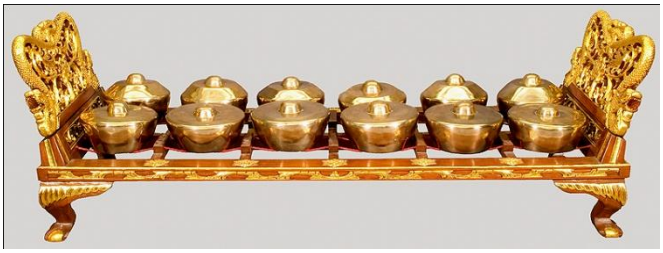


FIGURE 2.4. The "Bonang"

FIGURE 2.5. The “Saron”

2.2 Introduction to the Android Operating System

FIGURE 2.6. Android logo

Android is an operating system (OS) for mobile devices, which is developed by Google Inc. It caters the latest smart phones and table computers today such as HTC, Motorola, Samsung, Acer, Sony Ericsson, Asus and many more.

Statistically, Android OS has become the world's leading smart phone platform at the end of 2011 [5]. For the first quarter of 2012, Android OS had a 59% smart phone market share worldwide, with a 331 million devices installed base and 85 million activations or 934,000 per day [6]. This is largely due to Android OS having advantage of it being a multi-channel, multi-carrier operating system.

The Android OS has a number of version releases, with the latest currently being the Android 4.0 (Ice Cream Sandwich). However, Android 2.3 Gingerbread still holds the most number of users based on statistics (as of 1st June 2012) [7].

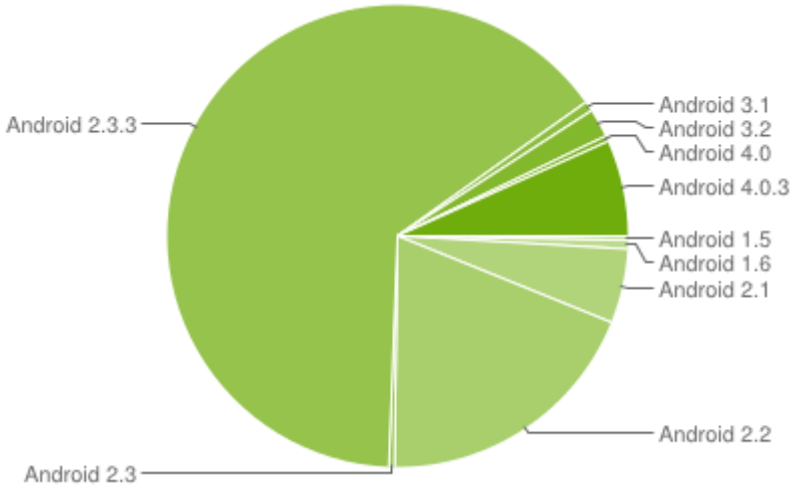


FIGURE 2.7. Usage share of Android OS version releases as of June 1, 2012

2.3 Current Music Mobile Applications Analysis

There have been several advancements utilizing Gamelan music. One of the few milestones occurring before the rise of mobile technology, uses Bluetooth technology. In 2006, the Faculty of Creative Arts of University of Wollongong did a research entitled “Pocket Gamelan: tuneable trajectories for flying sources in Mandala 3 and Mandala 4” [11]. The research describes new ways of doing live performances, which is using Bluetooth-enabled mobile phones. Interaction between mobile phones via wireless link is a key feature of the performance interface for each scenario. The mobile phones are used as sound sources and as hand-held controllers. Mobile phones are mounted in a pouch attached to a cord and physically swung to produce audio chorusing. One dedicated mobile phone acts as a server that interconnects multiple clients, while the other includes point to point communication taking place between clients on an ad hoc basis.

FIGURE 2.8. Mobile phones being used as flying sound sources in Pocket Gamelan

The research demonstrates the potential of musical applications to be generated with mobile phones. With only Bluetooth technology, researchers are utilizing Gamelan music as their experiments for live performance.

Today, as the Android increases its popularity among smart phone users, Android developers are on the rise to create smart and innovative mobile applications for the mass. Various genres of mobile applications are made available in the Android market, ranging from navigation, utilization, entertainment, education and many more. As of October 2011, it is reported that there are more

than 500,000 applications available for the Android OS [8], and the estimated number of applications downloaded from the Android Market as of December 2011 exceeded 10 billion [9].

Among the subject of interests among Android developers are music instrument digital simulators. Mobile applications that simulate musical instruments such as piano, guitars, or drums, has been one of the most popular applications to be downloaded by users. Due to the quick responsiveness of touch screens and touch sensitivity, music instruments are suitable to be projected as mobile applications, bringing realism closer to the user's fingers.

Gamelan, particularly the 'Bonang' and the "Saron", are percussive instruments. This means they are static, and will emit sound when hit, in this case, by mallets. Unlike the guitar or violin, there is no technical complexity to playing the instrument. In other words, from the mobile application point of view, users will only need to touch the specific parts, and it will play the sound. The Virtual Gamelan is similar to the large number of musical instrument applications in the market, that simulates instruments such as the piano, drums or drum pads.

Currently, there is a very small number of mobile application developers focusing to emulate the gamelan. One of the few, the "Gamelan", by ganzogo, is an Android application that allows users to play the "Peking". The application reaches its aim to simulate one of the gamelan instruments. The audio imitates the gamelan's tone well. Unfortunately, there is more that could be improved from this application. It has lag issues and some of the keys do not respond well. The interface only uses a still image, as opposed to the more aesthetic and interactive 3D graphic representation standardized today.

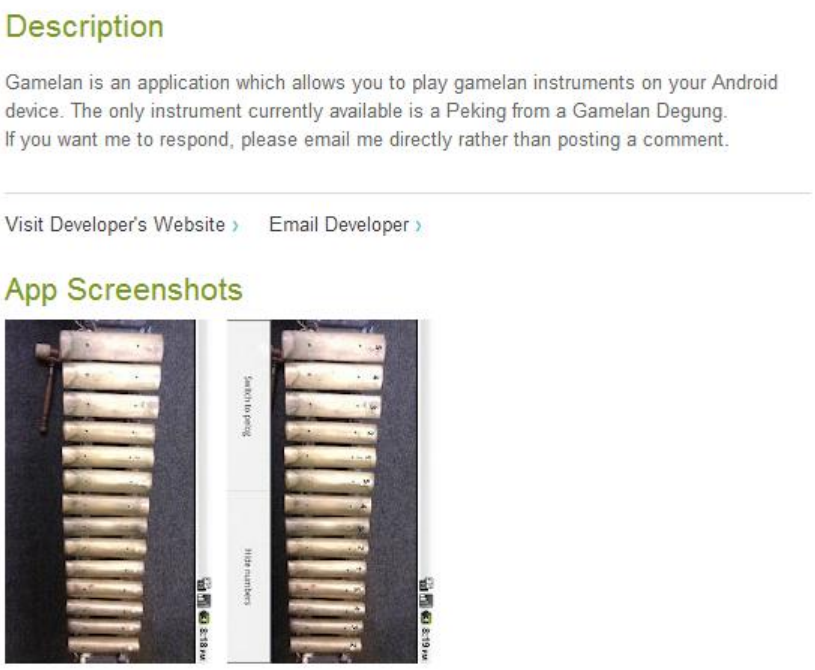


FIGURE 2.9. “Gamelan”, by ganzogo.

Gamelan DJ by kowplink, is an Android application that combines both traditional and modern DJ music. The concept is to mix beats and drum patterns with harmonies and melodies of the Gamelan. However, the application only lets the player use only one type of Gamelan instrument which is the Saron. Additionally, the involvement of modern influences sways the direction of Gamelan being retained in its original form, as the additional features are deemed unnecessary.

FIGURE 2.10. “Gamelan DJ”, by kowplink.

The “Gamelan”, by masagi studio is a similar application made for iOS. It works quite similar to the above application, “gamelan”, by ganzogo. However, it is

much better in terms of design, where a 3d-graphical interface is displayed. It also features key labeling, which is of great use for players who require notes and guide to play.

FIGURE 2.11. “Gamelan”, by masagi studio

Alternatively, analysis should not be constrained on gamelan mobile applications only. We should look into similar music applications around the market to gather more input and ideas. One of the best piano applications in the mobile market is the “Virtuoso Piano Free 2”. Developed for the iOS, it is praised for its simplistic design. The keys of the piano are represented well in a 3D graphical format. The interface is nicely arranged for the users to play, and it is touch-responsiveness works effectively. The application allows an option for the keys on the piano to be labeled with notes for users to easily understand it more. The features of “Virtuoso Piano Free 2” can be taken as an example to develop Virtual Gamelan, which requires the final product to be similar, but in a gamelan format.

FIGURE 2.12. “Virtuoso Piano Free 2” by Peterb

Based on the findings, there were several features that need to be implemented for the Virtual Gamelan to be a success. The representation and graphics of the gamelan needs to be proper and pleasing for users to play through. The responsiveness of the time between touching and playing the sound also needs to be clean and tight for it to maximize its functionality. The menu interface has to be simple and user-friendly for users to utilize.

TABLE 2.1. Comparison of similar applications

Application	Advantages	Disadvantages
Gamelan, by ganzogo	- Emulates tone.	- No touch sensitivity - Bad visuals with no interactivity (still image) - Lag issues/unresponsive at times. - Only features Peking.
Gamelan DJ, by kowplink	- Ability to mix gamelan with	- Only features Saron.

	modern beats and effects. - Interactive and appealing visuals.	
Gamelan, by masagi studio	- Features key labeling to assist playing.	- Only features Saron - Only available on iOS.
Virtuoso Piano Free 2, by Peterb	- Responsive - Slick graphical interface - Key labelling	- Is a piano application (which works similar to a the proposed application).

2.4 Basics of Learning Gamelan Music.

Gamelan instruments are mostly metallophone and gong type instruments which produce tones when struck with mallets. Additionally, other types of percussion instruments included in a regular gamelan ensemble are: a wooden xylophone (gambang), and a set of two headed drums (kendhang) played with the palm and fingers. Non-percussion instruments include the rebab, a two-stringed bowed instrument, a plucked zither-type instrument (celempung or siter), and a bamboo flute (seruling). A male or female singer, and a male chorus of two or three singers may also participate in a gamelan ensemble.

FIGURE 2.13. Gambang

FIGURE 2.14. Kendhang

Musicians in a Gamelan ensemble normally sit cross-legged before their instruments. It is most comfortable for the musicians to take off their shoes or sandals, and kneel on a cushion. Commonly, the musicians hold the mallets in their right hand, unless the instrument needs two mallets.

Traditionally, one learns to play gamelan aurally, in which one perceives the music and progressions by ear. This is a learning process in which one has to spend much time listening to and observing a gamelan performance. Several musical notations have been introduced and experimented with since the end of the nineteenth century. In present-day Java, cipher notation is commonly used as a teaching device and for analyses. Below are the traditional names of the pitches and their cipher equivalents.

Slendro tuning system, from low to high:

barang (1), gulu (2), dhadha (3), lima (5), nem (6)

Pelog tuning system , from low to high:

penunggul (1), gulu (2), dhadha (3), pelog (4), lima (5), nem (6), barang (7)

Most gamelan instruments are tuned to definite pitches corresponding to two kinds of tuning systems, which are the: five-tone slendro and seven-tone pelog. Therefore, a complete gamelan set of forty to sixty instruments are actually double sets of slendro and pelog gamelan, although they are never played simultaneously.

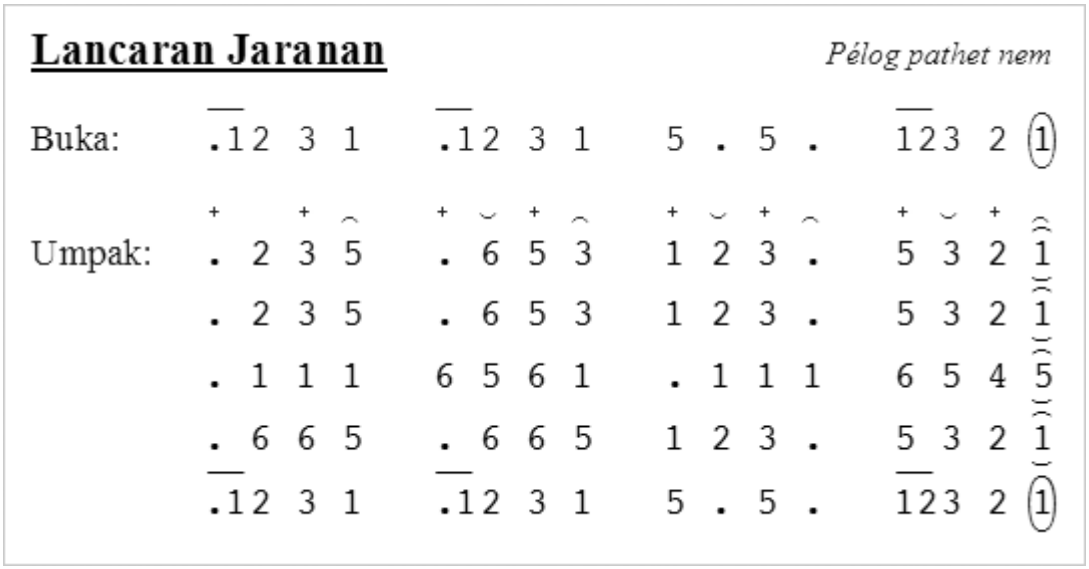


FIGURE 2.15. An example of a gamelan score

Each tuning system is characterized by its intervallic patterns. In slendro, the five intervals consist of short and medium steps. The difference between the two intervals in slendro is so small that they are often inaccurately described as equal or nearly equal intervals.

In pelog, although it has seven pitches per octave, sets of five pitch positions are used and combined. Thus, the pelog intervals consist of small, medium and large steps. Pelog is also pentatonic, but consists of three basic five-pitch scales. Unlike slendro, narrow and wide intervals in each of these scales are very apparent.

The seven pitches of a Saron and Bonang instrument are as below:

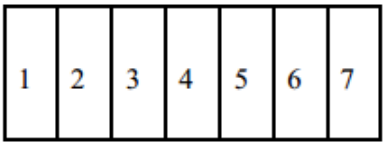


FIGURE 2.16. Saron pitches

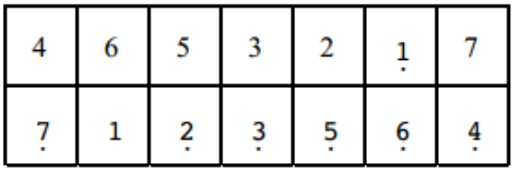


FIGURE 2.17. Bonang pitches

In a Gamelan ensemble, the Saron, which has thick keys, provides the high octave of the whole orchestration. There are different types of Saron, which includes the saron barung, and peking. The Saron barung is played with wooden mallets, while the saron peking is played with mallets made of horn. These instruments are played with the right hand holding the mallet slanting a little to the right to produce a full sound. The left hand acts as a damper by grasping the key with the thumb and forefinger. The damping of the key must be done at the same time the right hand strikes the next key. This helps prevent the key struck before to interfere with the next key.

Bonang are designed to have two rows of horizontal gong-kettles, placed open side down, on cords stretched over a rectangular wooden-frame. The gong-kettles are made of bronze. The bonang is played with two long sticks padded with cord at the striking end. Playing the bonang may be a bit tricky as the pattern of the arms will interchange at the middle.The bonang is considered important in leading all the other instruments in the ensemble.

CHAPTER 3

METHODOLOGY

3.1 Research Methodology

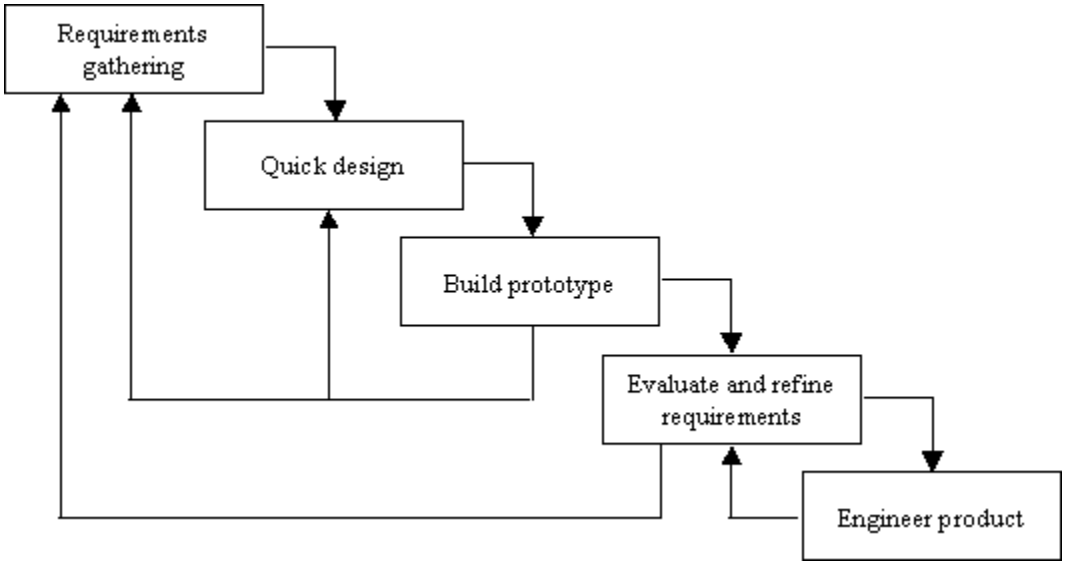


FIGURE 3.1. Prototyping Methodology

The method used to conduct the project was the prototyping model. For this project, the biggest aim is to create a virtual ‘Bonang’ and ‘Saron’ digital instrument. However, during the course of the project, this was prone to changes as the project progresses. There are ideas to add other instruments in the gamelan ensemble as well, or even add recording interfaces to further upgrade its usability, given there is enough time before the end of the timeframe. Due to the uncertainty of this, the prototyping model was implemented.

When the prototype was ready, it was given to test users, where their feedback was taken and analyzed. This benefited the progress well as it ensures the project’s functionality and usability goes in lieu with the objectives, or even more, to improve from the original vision. Corrections can be made early as the project progresses, lowering potential risks. Based on the capability of the project progress with the

time constraint, there may also be a chance to add extra characteristics to the product. Moreover, due to the limited time, the prototyping model is a suitable choice to work straight-forward without spanning a long period of time.

Basically, the project was stripped down into four basic phases which are:

3.1.1 Requirements Gathering

In this early stage, tasks required to be done are most importantly, to extract the requirements clearly. The objectives need to be amended and be made feasible, considering all the factors affecting the project. Much research needs to be done to plan this phase, such as determining market potential users. An analysis of the point of view of who the users are is important to know what to build with the project. Similar musical applications, such as Gamelan, piano, or drum applications, need to be reviewed and analyzed to see what is needed to be improved from these applications. Interviews need to be done: First, with Gamelan musicians and players, as to know what is needed to make this happen, and to correctly replicate the instrument as it is to the real instrument. Secondly, to interview mobile application users. This helps planning in developing the application to give maximum usability and satisfaction while operating the application. Much research into the field of Gamelan music and its instruments may also contribute to help develop the project. Research may be obtained from multiple relevant sources, such as the Internet, videos, music, performances, and reading materials. Combined research may very well hold the requirements of the project solid, and clear up the objectives of what is needed to achieve clearly.

3.1.2 Planning Phase

This phase has been reserved for analyzing the data and statistics gathered beforehand, and assembling it to help organize the

flow of developing the project. From the requirements gathered at the stage before, this phase leaves space to plan the solutions to complete the requirements needed. Matters to be planned include, the set of tools needed to build the prototype, the features needed to be included in the application, as well as the timeline of the whole project to complete all within the given deadline. It involves a lot of organizing logistics to help ease the flow of building the prototype during the next prototyping phase. The deliverables of this phase will supposedly pave way to make up the initial design of the prototype.

3.1.3 Prototyping/Implementation Phase

After all the necessary requirements and planning has been set, development could then be initiated to build a prototype. It will probably be the longest phase as much will need to be developed to achieve the objectives. Activities executed was conducting a recording session for the sound of the “Bonang” and “Saron”, and building the application on the development kit. The prototype could allow for numerous testing of the product during the iteration period. From the prototype, a number of tests was drew such as validating whether the system specifications could meet the requirements, addressing any newly discovered requirements, and uncovering any design flaws.

3.1.4 Evaluation and Maintenance Phase

With the basic prototype completed, the draft of the project can now be tested with target users. The prototype must reach a certain level of approval to maintain an acceptable performance rate. Testers and potential users will be given the chance to try out the application. Feedback would be gathered from these group of people, and from these feedbacks, it would be analyzed and taken into consideration to

help improve the project. Few points to take into account when analyzing are to measure whether the virtual instruments sound like what it is intended, or to measure whether it is accurately touch-responsive, or if it is user-friendly for the user to navigate through. A method used was the System Usability Scale (SUS). This method is useful for measuring the usability of the product with testers. It is a simple questionnaire with ten items that measures the application's effectiveness, efficiency and satisfaction while using the application. Additionally, while user testing is in progress, user's comments about the application will be noted down to acknowledge their personal review on the application. By the end of the review and evaluation phase, the final product should be completed for release.

3.2 Tools

For the project, the Virtual Gamelan mobile application will run on the Android operating system. This is chosen based on a number of factors. One being that Android has a large community of developers writing applications that extend the functionality of the devices. As there are active participation within or outside the internet community, it is safe to choose the Android as there is wide support to build the application. Mobile applications running on Android are even far more accessible as compared to the other platforms. In October 2011, there were more than 500,000 apps available for the Android, and the estimated number of applications downloaded from the Android Market as of December 2011 exceeded 10 billion [10].

As the Virtual Gamelan will be running on the Android OS, there are two basic tools needed to develop a mobile application on the Android platform which is; the mobile device to run the mobile application, and the toolkit needed to develop the mobile application.

3.2.1 Mobile Device

A tablet device running the Android operating system is required to run and test the mobile application. For the project, the mobile application was mostly tested on the Samsung Galaxy Tab 7.7 running on the latest Android 4.0.4. This tablet is a suitable choice for the application to be hosted on, as its large screen resolution of 1280x800 made it easier for the instruments to be played. It is also one of the most reliable android devices currently popular among tablet users. It is a benchmark for Android tablets as compared to other tablets.

FIGURE 3.2. The Samsung Galaxy Tab 7.7

However, different Android mobile devices with different versions and screen sizes was used to test its compatibility on different devices. Additionally, it was also be tested on Android smart phones as well to test its compatibility on the smaller phone devices. As planned post-project, it is envisioned for the project to be usable on all sorts of Android devices.

3.2.2 Software Development Kit (SDK)

The development of the Virtual Gamelan was done using *Eclipse,* a multi-language software development environment comprising an integrated development environment (IDE). Program was written mostly in Java. The Eclipse SDK is a free and open-source software. It also includes the Eclipse Java development tools (JDT), which offers an IDE with a built-in incremental Java compiler and a full model of the Java source files. This allows for advanced code analysis. Eclipse is found to be fairly convenient for mobile application developers, and is one of the

best SDKs around, making it a good choice for the application to be developed on.

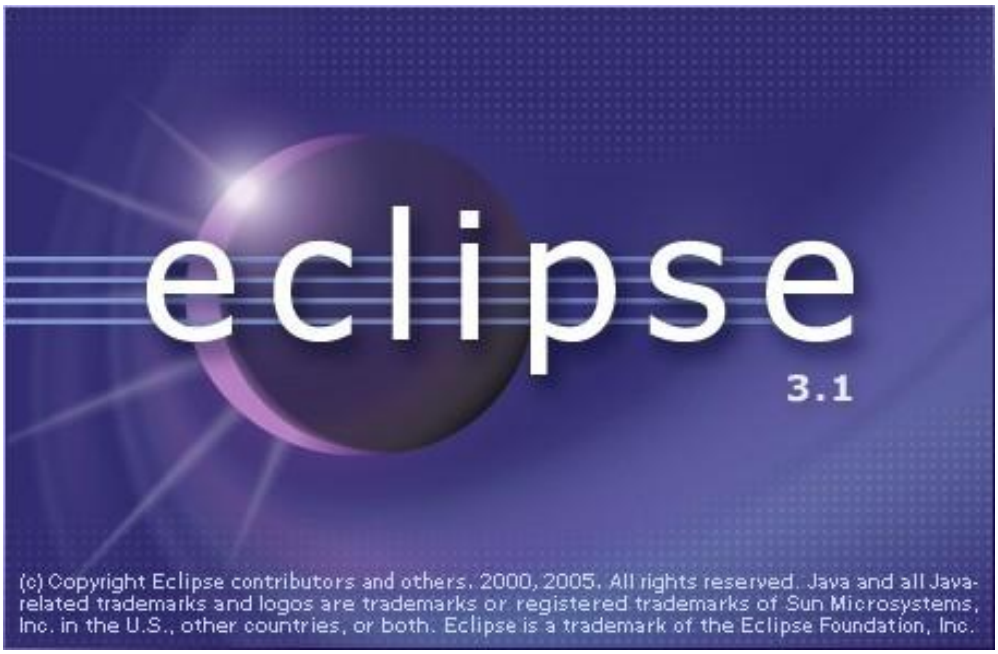


FIGURE 3.3. Eclipse Software Development Kit

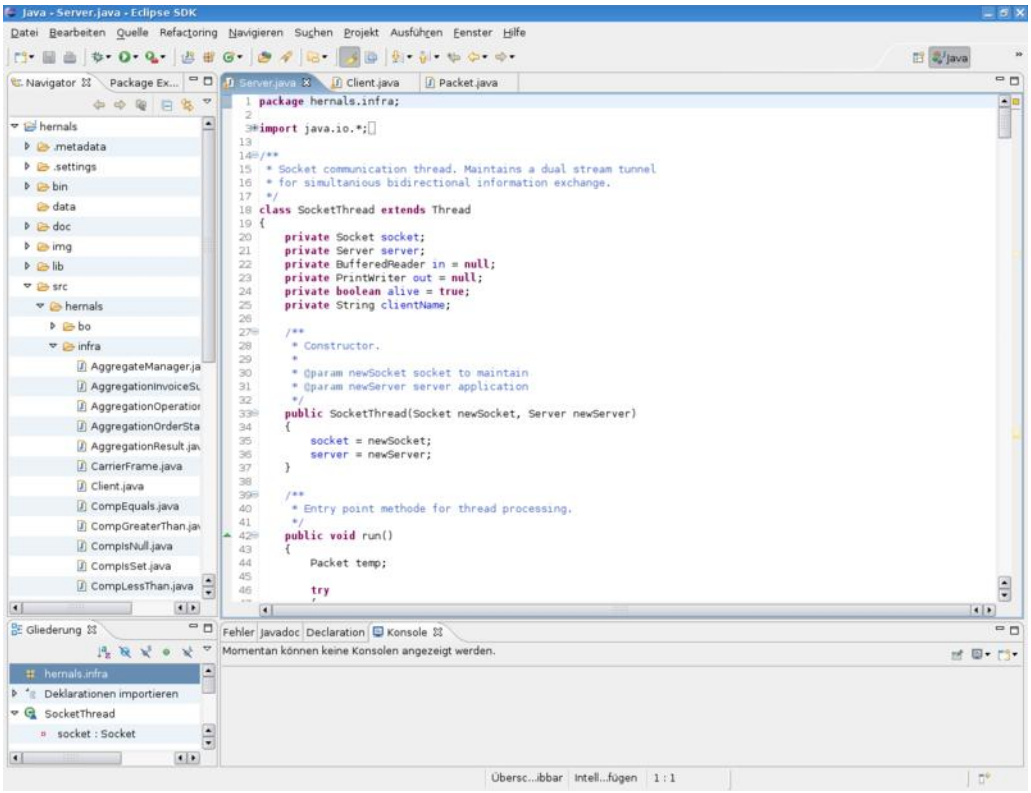


FIGURE 3.4. Screenshot of Android development in Eclipse

3.2.3 Recording Device

The virtual gamelan used original audio files from the real instruments to retain the Virtual Gamelan in its original form. Hence, an audio recording device was used to gather the audio files. For this project, the Zoom H4N, a professional stereo microphone was used to record. With the right circumstances, like setting up a room with no noises, the Zoom H4N recorded the audio files clearly. These audio files was then be implemented into the application.

FIGURE 3.5. Zoom H4n

3.3 Gantt Chart

TABLE 3.1. Final Year Project 1 Gantt Chart

Activities/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Project Proposal / Requirements Gathering														
Literature Review Research														
Conducting Interviews														
Finalize Requirements														
Storyboard / Flowchart / Wireframes / Designing														

TABLE 3.2. Final Year Project 2 Gantt Chart

Activities/Week	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Recording / Photographing of instruments														
Development on Eclipse SDK														
User Testing / Evaluation														
Pre-SEDEX														
Final Viva														
Submission of Final Report														

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Interview

To assist development of the project, I have acquired input from a professional having expertise in Gamelan music. An online interview was conducted on the 3rd or August 2011 with Muhammad Hafiz 'Arif bin Ahmad Sayukhi, a Bonang player of the UTP Gamelan Group, Sanggar Kirana. The interview was done through phone, email and the Gtalk chat service. The objective of the interview was to gain insight from a Gamelan player's point of view, and gain recommendations on developing the application.

The interviewee finds the idea of Gamelan being converted into digital mobile form is something that is fresh and new. As there is not a significant Gamelan mobile application being active among mobile devices, the interviewee absolutely appreciates and motivates the effort being done.

From his perspective, his expectations for the mobile application to be a success is by making sure the right sound is being produced by a particular key. The interface needs to be user-friendly and pleasant to be used. Responsiveness is also an important part that needs to be executed well, ensuring sounds are being produced immediately after the instruments are touched. The interviewee feels that although the real instruments are striked with mallets and hammers, the fingers would not be a problem as long as it retains the same feel and intensity of playing the real thing. The notes and octaves should also be crafted exactly like the real instruments.

Extra recommendations from Muhammad Hafiz suggested additional instruments such as the gambang. He also thinks that it will be a great tool if it can include a feature to learn basic songs with notes for beginners.

To end the interview, Muhammad Hafiz hopes the gamelan Android application would be a success. He feels the Virtual Gamelan would excite the passion of many Gamelan lovers, and it would be of great convenience for the Gamelan to be played just with fingertips.

4.2 Touch Screen Technology

The Virtual Gamelan would be focused to be developed for tablet devices, which generally uses touch screen technology. Touch screens on either smart phones or tablets have garnered much popularity today and is generally the most used by mobile users. Touch screens has several advantages for its intuitiveness and convenience. It promotes a visual display with direct manipulation that is easy to navigate, suitable for applications with musical concepts such as piano, drums, and gamelan instruments.

There has been an alternative to develop it for the computer. A program on a computer would be controlled by a keyboard. Below is tabled the comparison between touch screen and keyboard technologies.

TABLE 4.1. Comparison of touch screen and keyboard technologies

	Touch Screen	Keyboard
Sensitivity	- Touch-sensitive. Response varies according to pressure of touch. The higher the force, the louder the sound.	- Not touch sensitive.
Immersiveness	- More interactive as user touches the instruments themselves with the fingers.	- Less interactive as user presses keyboard
Ease of use	- Uses less space. User interacts with the menus and interfaces directly without any use of touch pads.	- User needs to interact with keyboard, where responses are output through the monitor.

4.3 Storyboard, Flowchart and Wireframe

Figure 4.1 shows the storyboard of the software. When the user initiates the application, firstly, the application will show the splash screen for about three seconds. Splash screens are integral to introducing the user to the application. It represents the first impression of the user towards the application. Hence, the splash screen must be designed nicely to the application's theme. The splash screen will display the application's logo, and a short Gamelan melody will be played to immerse the users.

Then, the application's main menu will be shown. This is where the users will be given the options to choose between its three modules: "About the Gamelan", "Demonstrations", and "Play the instruments".

If the user presses "About the Gamelan", the user will be shown information about Gamelan music. Information displayed will be about what the Gamelan really is, how it is played, its history, and samples of Gamelan music in audio or video form. This section translates the application to be an educational tool about Gamelan, for it opens a lot of introduction knowledge for interested users.

The "Demonstration" section lets the user see videos of how these Gamelan instruments are played. For each playable instrument featured in the application, there will be an instructional video of how these instruments are struck and how it sounds like. These instructional videos will be taken from the Internet. It would be helpful for beginners learning to play the Gamelan instruments.

The "Play" section brings its users to the application's main feature, which is playing the instruments itself. By choosing either Bonang or Saron, users will be led to the display of the instruments. They will play the instruments by using their finger touch on the graphical representation as the input. Once touched, a sound will immediately be generated based on what the user has pressed as the output. Each interface from the first menu has the option to go back to the previous interface to make sure smooth workflow between interfaces. The choice of instruments will be the Bonang, Saron, Gambang and Gong, although the ones playable for the project shall be the Bonang and Saron. However, as time progresses, the Gambang and Gong shall be included later.

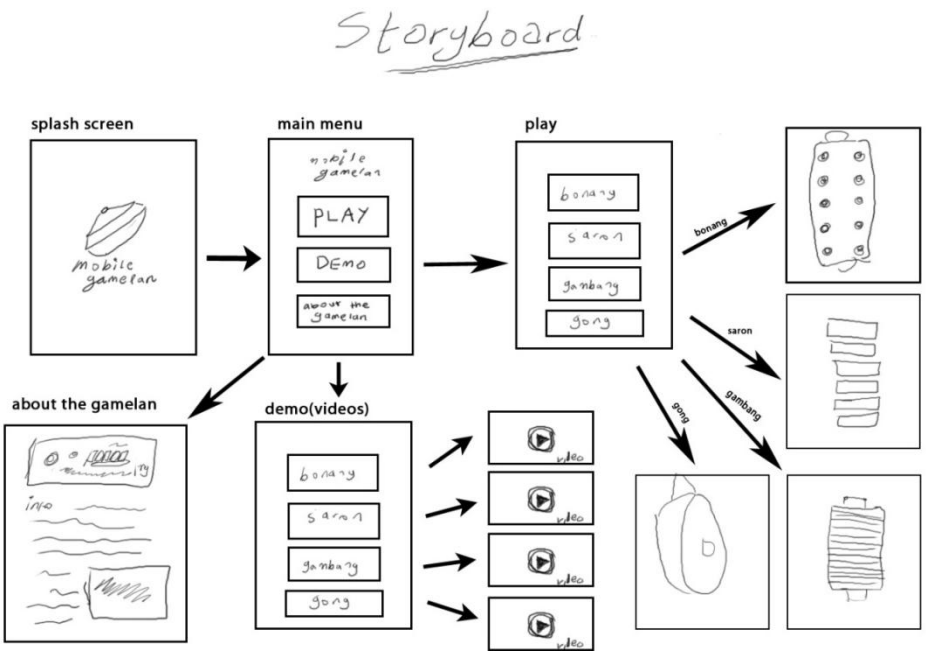


FIGURE 4.1. Storyboard of the software

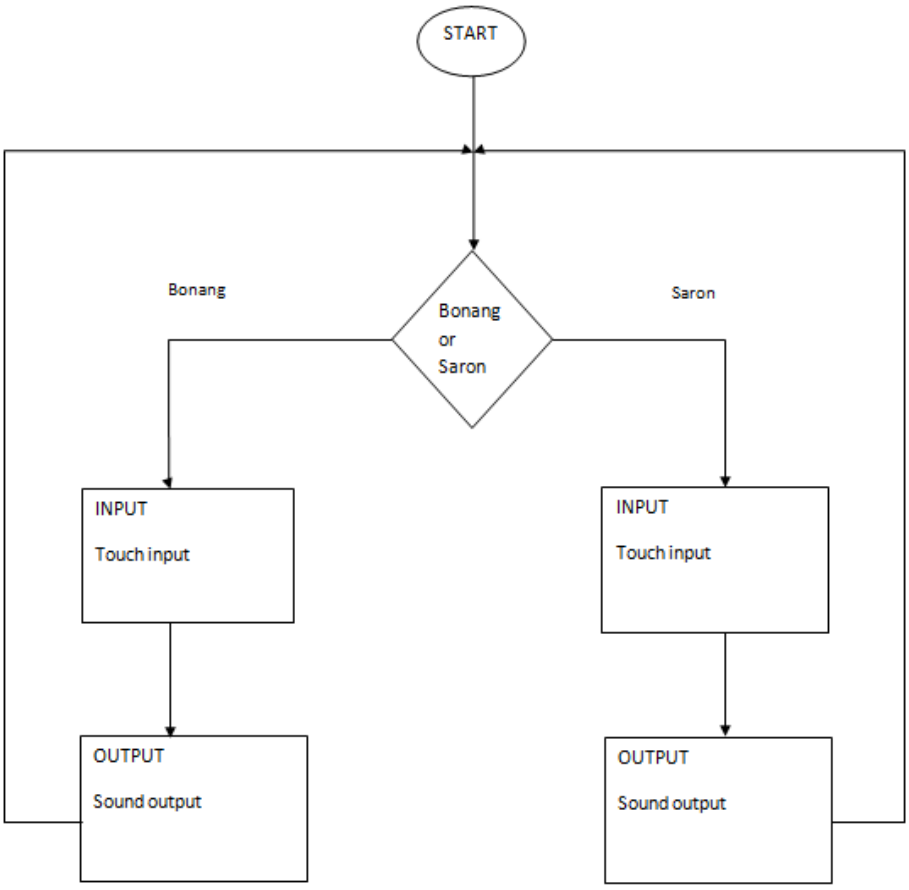


FIGURE 4.2. Flowchart for the Play section

FIGURE 4.3. The first wireframe of the software

To make the application function accordingly, where the fingers touch the notes and the sound plays, a draft of how its functionality works is fingerprinted. A button will be placed on the back interface, where each area will have its separate sound file. The sound files will be recorded from the real instruments. The sound files will then be saved to each button accordingly. The graphical interface of the instrument will then be layered on the topmost part to function as the user interface.

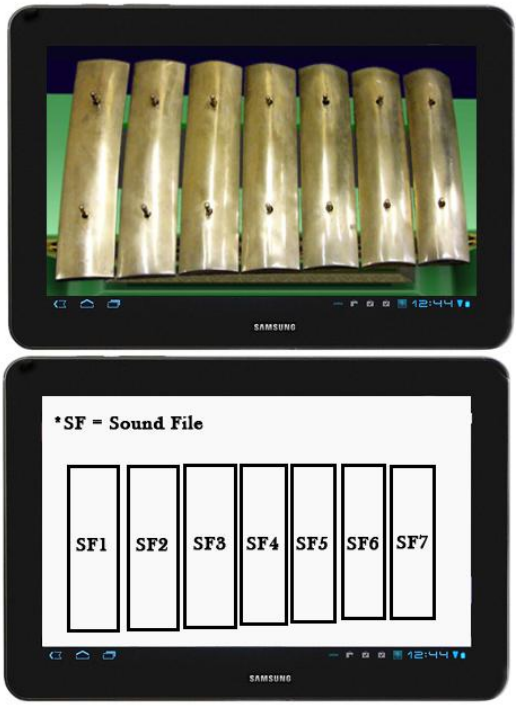


FIGURE 4.4. Interface of the Gamelan Saron. Top is the graphical user interface. Below is the underlying interface.

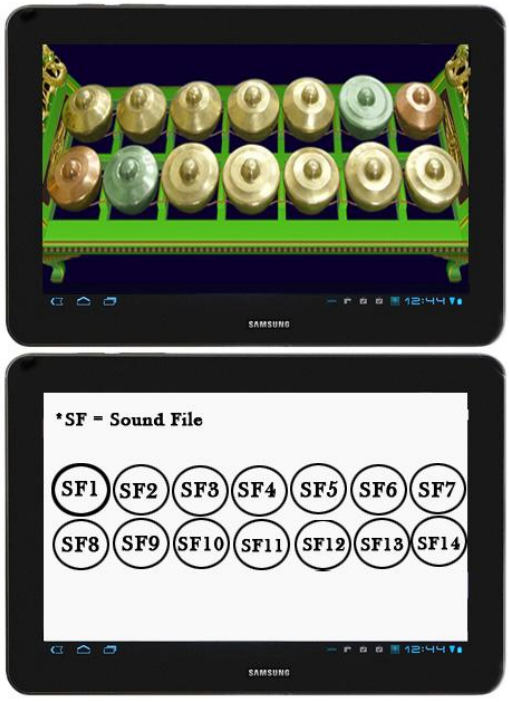


FIGURE 4.5. Interface of the Gamelan Bonang. Top is the graphical user interface. Below is the underlying interface.

An added feature will be key labeling. Key labeling is an option which can be enabled by the user. It will label the instruments with notes which helps beginners learning which is which. It will also help users play according to scores, provided they are both in the same tuning and scale. The prototype examples below shows how it is if the user chooses to leave this option enabled:

FIGURE 4.6. Saron with key labelling

FIGURE 4.7. Bonang with key labeling

4.4 Software Prototype

Figure 4.8 below shows the Android Home menu where the Virtual Gamelan application icon is visible for user to click on if he wishes to initiate the program.

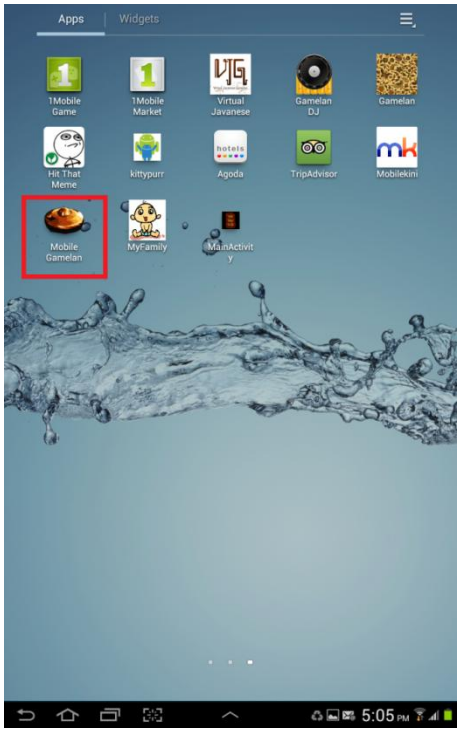


FIGURE 4.8. Application icon on an Android home screen

As soon as the icon is clicked, the program starts with a three second splash screen displaying the application's logo and title. A short melody of the Gamelan also accompanies the splash screen to add to the attractiveness of the application's introduction.

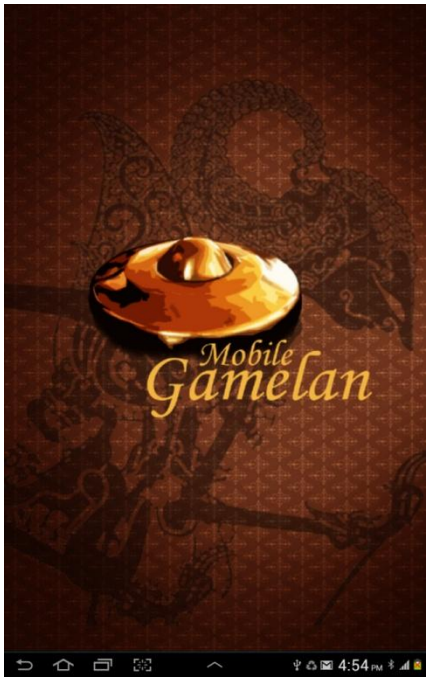


FIGURE 4.9. Splash screen of application

Figure 4.10 shows the main menu of the application. The user is given three choices: “About the Gamelan”, “Demo” and “Play.

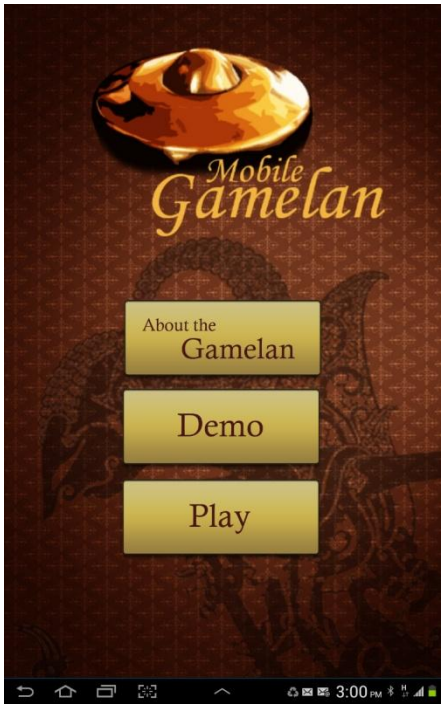


FIGURE 4.10. Main menu of the application

Should the user presses on “About the Gamelan”, the user will then be led to another sub-menu which displays three other options: “About Gamelan music”, “History” and “Live Videos”.

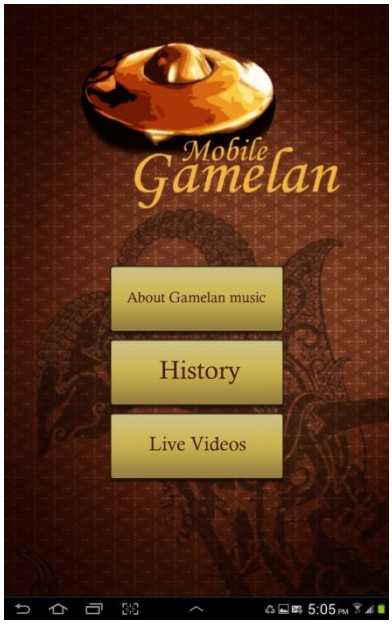


FIGURE 4.11. “About the Gamelan” sub-menu

The first main module, “About the Gamelan” features descriptions about Gamelan and Gamelan music in general. “About Gamelan music” explains what Gamelan is, its origins, the instruments in an ensemble, and other relevant information about it. It features text and and interesting images to ensure a comfortable reading experience for the user. The “History” page displays similarly to “About Gamelan music”, but focuses more about the Gamelan’s rich history. Information being displayed includes its first emergence founded in artifacts from Central Java, the Gamelan’s signature melodies, its uses in traditional activities and resemblance today, as well as its presence in Malaysia. “Live Videos” lets the user sees how a Gamelan ensemble plays in video form. The best Gamelan performances are featured in the application to let the user experience the full potential of Gamelan music.

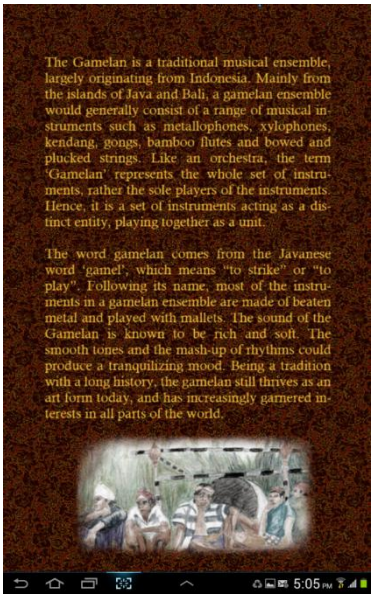


FIGURE 4.12. "About Gamelan music" screenshot

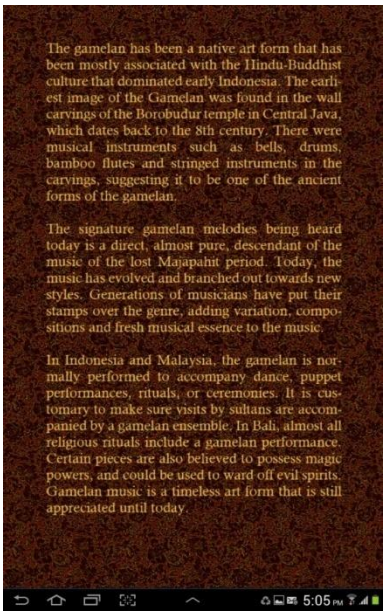


FIGURE 4.13. "History" screenshot

The second main module, "Demo", is a compilation of instructional videos about the Gamelan instruments. The videos being featured are in coherence with the playable instruments in the application, which are the Bonang, Saron, Gambang and Gong. The videos are complete tutorials of how to play them properly. This section serves as a learning tool for beginners to know how to play the instrument, and acts as a tutorial for first time users to go through before playing.

The third main module is the “Play” section. This is the main attraction of the application where the user is allowed to play the Gamelan instruments. After clicking “Play”, the user is led to its sub-menu, which is a list of available Gamelan instruments to play on. The playable instruments are the Bonang, Saron, Gambang and Gong.

FIGURE 4.14. “Play” sub-menu

Figure 4.15 below shows the “Saron” screen. A close-up shot of the Saron instrument is displayed. It is enlarged to enable easier playing for the user to touch. When the user touches the metallic bars, its respective sound note will emit on touch. To add to the realism, it is multi-touch. The Saron also has a different way of playing. After a note has been struck, the players would hold the metallic bar’s edge to stop the note in order to avoid it from sustaining, where it will meddle with other notes struck afterwards. Hence, in the application, the user also has the ability to stop the notes by touching the low edge of the metallic bar. At the bottom of the screen is the option to enable note display. If the user chooses to enable it, a note will be displayed on each metallic bar. This makes it easier for the user to identify the notes.

FIGURE 4.15. “Saron” screenshot

FIGURE 4.16. “Saron” screenshot after enabling notes

Figure 4.17 below shows the “Bonang” screen. Similar to the “Saron” screen, it displays a close-up shot of the Bonang. Practically, the method of playing the Bonang needs the user to use two hammers, where it is played simultaneously at times. Hence, the multi-touch is fully utilized in this implementation. Note display is available as well for users.

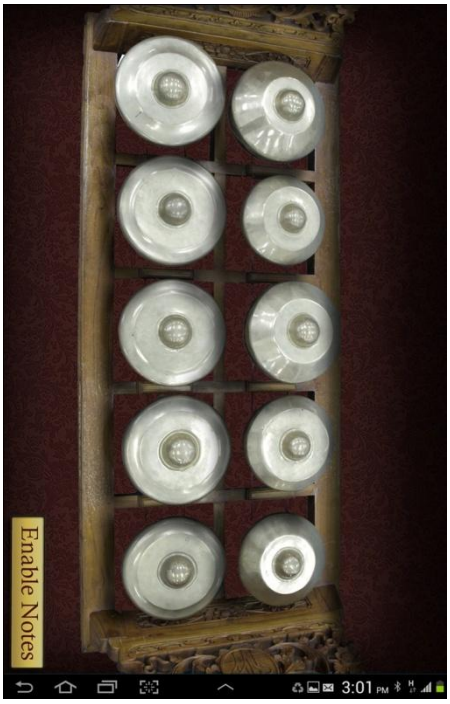


FIGURE 4.17. “Bonang” screenshot

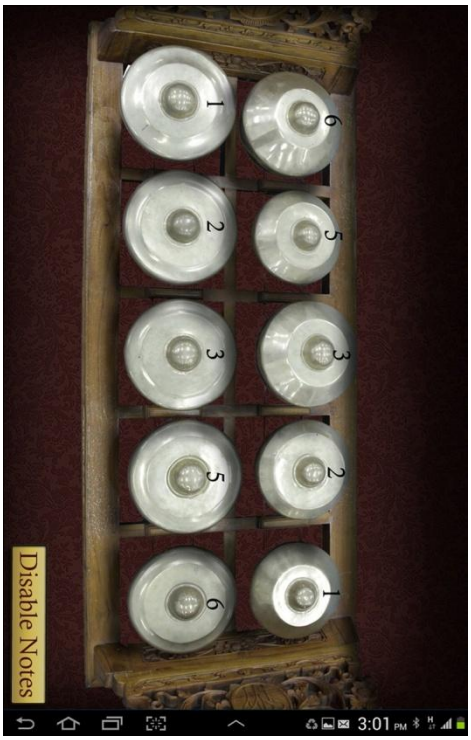


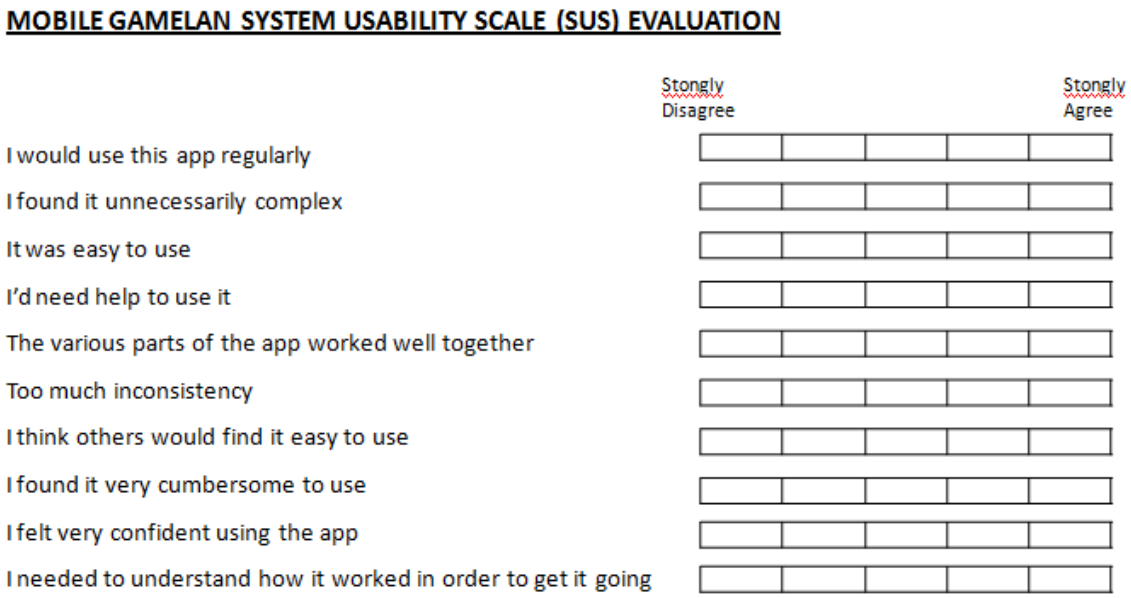
FIGURE 4.18. “Bonang” screenshot after enabling notes

4.5 User Testing Results

To evaluate how well the project is done, user testing was done on potential users. A total of 15 correspondents were given the application, where five where Gamelan musicians. The rest were usual mobile device users.

To test the usability of the application, a System Usability Scale (SUS) evaluation was conducted. The SUS is a usability test with ten simple questions that gives a global view of subjective assessments of usability. It will result in a single score on a scale of 0-100, where the higher the score, the better the usability of the software. The SUS evaluation is known for its simplicity, and gives a rough idea of a performance of a software.

Testers was given the application either through download, or through tests on the tablet showed to them. They were given the chance to play around with the software without any form of guidance. After testing, they were given a questionnaire with ten questions, vital to a SUS evaluation.



MOBILE GAMELAN SYSTEM USABILITY SCALE (SUS) EVALUATION

	Stongly Disagree				Stongly Agree
I would use this app regularly					
I found it unnecessarily complex					
It was easy to use					
I'd need help to use it					
The various parts of the app worked well together					
Too much inconsistency					
I think others would find it easy to use					
I found it very cumbersome to use					
I felt very confident using the app					
I needed to understand how it worked in order to get it going					

FIGURE 4.19. SUS evaluation on prototype

The data were collected from the questionnaires given. The total score of all the correspondents were multiplied with 2.5. The sum will then be averaged with the total number of user testers. This resulted in a SUS average score of 86.6, which is quite satisfactory. The results are shown in figure below. The number beside each

question bar is the average SUS score for the total the number of correspondents on the respective question.

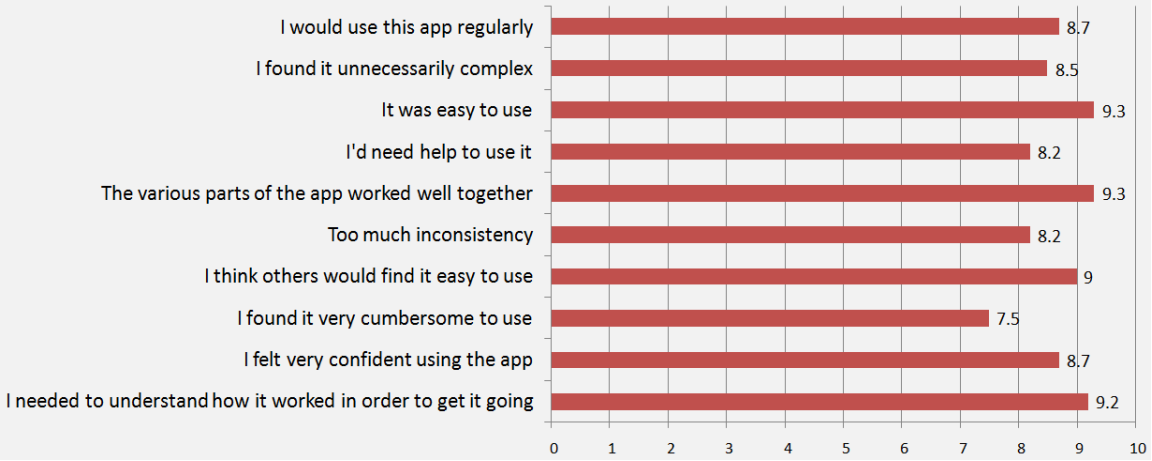


FIGURE 4.20. SUS results bar chart

Besides the SUS evaluation, user comments were gathered while the app was in use and after use. Overall, comments were positive and complimented the quality of the music instruments in terms of sound and graphics. Navigation through the menus was easy and direct. Most users were satisfied with their experience with the application. Constructive criticism included that the app would be better with the whole set of Gamelan instruments finished. The responsiveness would sometime have little latency. However, this may contribute from the user's mobile devices themselves. Additional comments were of that they wished for more extensive features, such as the ability to record the playing.

4.6 Challenges Faced

The development of this project has faced a lot of obstacles. The hiccups served as lessons learnt to better upgrade the idea of the project and make it a success.

One of the early challenges to overcome was collecting research data to help build the project. The subject comprises historical information, as the instruments and field of music dates back to centuries, and also to today's information, a whole lot knowing about fusing these historical values to the technology available today. Tackling the subject matter was not an easy task. Information needed to be gathered way back to its origins, to know the essence of the music itself. Research included knowing the purpose of the music, its uses in the past and present, and most importantly, knowing how to operate these instruments. Although the Internet provided some information from articles, research papers and videos, the old subject was scarce, made probability due to the disinterest and low popularity of the type of music which was very traditional. Nevertheless, it was overcame with great research from key people from the likes of students and a teacher, from the university's Gamelan group, which would be a lot to thank for.

The next challenge was making sure what the project entails stays true to its actual form. The challenge was creating and emulating something real to a digital form. There are a lot to be taken in, such as knowing the texture of the sounds, mapping the instruments shape into graphics, and other related points. The way to play these instruments also plays an important aspect in developing the application. How Gamelan players react with their instruments are totally different. As an example, the idea of finding ways to translate the real way of playing the instruments which is by hammer and force, to only touching these instruments with the press of a user's fingers.

Development with the software development kit has been the biggest challenge to overcome so far, much of it dealing with the technical complexities of implementing an idea to work. One of it was about dealing with Android's sound widgets. The initial sound widget used MediaManager, but it turned out to have high latency, which is not recommended for a responsive needed application. Then, it was decided to use SoundPool, which worked well with handling immediate playback of the instruments. Other complexities included the original sound on press

release Android has, which means that the sound will be played after the use releases his fingers from the device screen. This implementation will not be proper as it contributes to the lag of each note. It was overcame by changing specific programming implementations in the code. Additionally, there was the problem of making the application compatible with different screen sizes mobile devices have. The application needs to be standardized so that it works on all screen sizes, to avoid stretching of graphics. Hence, different mobile devices with varying screen sizes needed to be acquired for the application to be tested on to make sure it works on all.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

The project finally reaches to an end as the software is completed. The publication of the mobile application will meet the demands of musicians interested to play Gamelan music with ease. Furthermore, it leaves the door open for usual mobile device users to enjoy the musical instrument and to learn something new from the historical art form.

As per the objectives of the project, the software has met the said aims and objectives. After user testing with potential users, it has proven to satisfy musicians. It has also exposed Gamelan music to people unaware of its existence. The Gamelan instruments were successfully emulated as a digital form for the mobile device market. Moreover, it has utilized multi-touch capabilities of Android devices. User experiences have also been evaluated where it has showed positive results.

However, the project will still be left open for further development. It is planned for the application to still continue developing. Added features will bring in other Gamelan instruments, and to aim to fully enhance the platform's capabilities in the future. It will also be released on the market globally to be distributed worldwide for users to download from. It is in its vision to bring Gamelan music attention from around the world, and with today's technology, it widens the possibility to achieve it.

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APPENDICES

FIGURE 6.1. Gamelan Saron recorded and photographed for the project

FIGURE 6.2. Gamelan Bonang recorded and photographed for the project

Technical Report

Virtual Gamelan Mobile Application

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ABSTRACT

The Virtual Gamelan is a mobile application that simulates gamelan instruments, built for mobile devices using the Android operating system. The Virtual Gamelan attempts to recreate the "bonang" and the "saron", which are instruments part of a normal gamelan ensemble, into digital form, suited for mobile use. The gamelan is a traditional musical ensemble originating from Java and Bali in Indonesia. It is an ancient art form which dates back to the 8th century. The gamelan is known for its rich and blended sound signature, and melodies that sparks tranquility and meditation. The art has garnered interests in all parts of the world, and also has a presence in Malaysia, having its own version called the Malay gamelan. The gamelan has been a part of a long historic culture, especially in Indonesia and Malaysia, as it has been always used in royal ceremonies, as well as formal events and occasions today. However, the popularity of the traditional art form seems to be in decline, as new modern music genres appeals more to today's generation. Making use of mobile technology, the Virtual Gamelan attempts to revive the traditional gem to today's modern world, in hope of exposing the gamelan more to the public.

I. INTRODUCTION

The Gamelan is a traditional musical ensemble, largely originating from Indonesia. Mainly from the islands of Java and Bali, a gamelan ensemble would generally consist of a range of musical instruments such as metallophones, xylophones, kendang, gongs, bamboo flutes and bowed and plucked strings. Like an orchestra, the term 'Gamelan' represents the whole set of instruments, rather the sole players of the instruments. Hence, it is a set of instruments acting as a distinct entity, playing together as a unit.

The word gamelan comes from the Javanese word 'gamel', which means "to strike" or "to play". Following its name, most of the instruments in a gamelan ensemble are made of beaten metal and played with mallets. The sound of the Gamelan is known to be rich and soft. Being a tradition with a long history, the gamelan still thrives as an art form today, and has increasingly garnered interests in all parts of the world.

Today, even though not prominent, there is still an interest to revive the music of the gamelan, and gamelan troupes have been growing and promoted especially in higher learning institutions.

A. Problem Statement

Gamelan is an orchestra instrument, which requires a large number of people for the music to be executed well. It is not a favorable instrument for people to own, due to a few factors explained below.

Gamelan instruments are not preferable for people to own because of the instruments are being made of steel, iron, bronze or brass. Its large sheer size makes it heavy in weight, resulting in such a difficult item to carry around, especially by touring musicians.

The exotic material to make gamelan instruments contributes a lot to the gamelan's rich tone. However, the materials do not come in cheap and are made from hefty materials such as steel, iron, bronze or brass. Prices are often hiked up due to the artistic complexity of the carvings on the wooden case of a gamelan instrument. For example, A gamelan "peking", the smallest in a gamelan ensemble, could fetch up to at least RM300. Given its expensive price, to purchase one type of gamelan instrument on its own may be seen as pointless, due to its nature of being better suited to play with the other gamelan instruments together.

Due to these inaccessibility factors, Gamelan instruments are difficult for people to own. Gamelan instruments are often grouped together in a practice area. So whenever players would like to practice, they would have to attend to the practice room in order to rehearse. It is not mobile for them to easily bring around anywhere.

As we enter the modern era, traditions pass by quickly, and are slowly being forgotten away. New innovations in musical instruments such as electric guitars or keyboard

synthesizers has rise more in popularity among the younger generation. Popular modern music today has replaced music by past generations. The mass now are more exposed and influenced to music from the West, which makes them tend to forget about their own cultural roots. Without any initiatives to revive the gamelan back, the gamelan may be on their way to extinction. Hence, something has to be done to make the public appreciate the tradition more.

B. Objectives.

The aim of this project is to study the essence of Gamelan music, and connecting it with modern technology. The objectives include:

1. To expose Gamelan music to the public and preserve the traditional art form, through the use of mobile technology.
2. To explore the use of multi-touch capability of mobile device interface for playing Gamelan instruments.
3. To emulate the Gamelan as a mobile application.
4. To evaluate user experience with the Virtual Gamelan.

C. Scope of Study.

Two instruments has been chosen to be featured in application: the "Bonang" and the "Saron". The reason is because these two instruments are practically at the forefront of a Gamelan ensemble. The metallic bars and gongs signify the unique Gamelan sound.

The Virtual Gamelan targets users of all ages. Everyone from children to adults could use the application. It is also a universal instrument where it does not necessarily targets a certain group of users, from musicians to casual mobile device users.

The application is hosted on the Android Operating System. It is a multi-channel and flexible operating system where it encompasses a wide range of mobile device brands such as Samsung, HTC or Acer. The audience and potential users of the Android are wide, making it an appropriate choice for the Virtual Gamelan to be hosted on.

Universiti Teknologi PETRONAS (UTP) has its set of gamelan instruments as part of its curriculum structure. The instruments owned by the university are often featured in performances by UTP's very own gamelan group, Ensemble in G. Having the gamelan instruments available in UTP, research was done here within the campus. Experienced tutors and gamelan players were reached easily for research purposes.

II. LITERATURE REVIEW

A. A Brief History and Background of the Gamelan.

The gamelan has been a native art form that has been mostly associated with the Hindu-Buddhist culture that dominated early Indonesia [1]. The earliest image of the Gamelan was found in the wall carvings of the Borobudur temple in Central Java, which dates back to the 8th century. There were musical instruments such as bells, drums, bamboo flutes and stringed instruments in the carvings, suggesting it to be one of the ancient forms of the gamelan.

In the fourteenth century, people from the Middle-East introduced Islam throughout Indonesia, which brings to the fall of the Majapahit Empire. The signature gamelan melodies being heard today is a direct, almost pure, descendant of the music of the lost Majapahit period [2]. Even though the tools and identity of the gamelan is still preserved until today, the music has evolved and branched out to new styles. Generations of musicians have put their stamps over the genre, adding variation, compositions and new musical essence to the music.

Alternatively, the evolving gamelan that grows until today is the sum of diverse foreign influences. For example, bronze instruments mainly from South East Asia, drums from India, bowed strings from the Middle East, and even military styles from Europe contributes to the traditional music that could be heard in Java today.

In Indonesia, the gamelan is normally performed accompanying dance, puppet performances, rituals, or ceremonies. Gamelan plays an important role in Indonesia' rich culture, as the sound shapes the identity of their heritage activities. For example, the gamelan's role in rituals is so important that there is a Javanese saying, "It is not official until the gong is hung" [3]. It is also customary to make sure visits by sultans are accompanied by a gamelan ensemble. In Bali, almost all religious rituals include a gamelan performance. Certain pieces are also believed to possess magic powers, and could be used to ward off evil spirits [3].

In Malaysia, the gamelan has its version in itself. The Malay gamelan still retains the same instruments as the Javanese or Balinese gamelan. Malay gamelan music sounds more simplistic, in that nearly all the instruments play the melodies, unlike the intricately locked parts of the Javanese gamelan.

Today, there is an interest to revive gamelan music throughout Malaysia and beyond, with efforts of promoting and writing gamelan music being pursued by local musicians, such as Ariff Ahmad and MonoLoque. Various local institutions such as Universiti Malaya and Universiti Teknologi PETRONAS, have set up their own gamelan ensembles. The effort to promote the gamelan movement is still active in a hope to appeal more to today's youth.

B. Introduction to The Android Operating System.

Android is an operating system (OS) for mobile devices, which is developed by Google Inc. It caters the latest smart phones and table computers today such as HTC, Motorola, Samsung, Acer, Sony Ericsson, Asus and many more.

Statistically, Android OS has became the world's leading smart phone platform at the end of 2011 [4]. For the first quarter of 2012, Android OS had a 59% smart phone market share worldwide, with a 331 million devices installed base and 85 million activations or 934,000 per day [5]. This is largely due to Android OS having advantage of it being a multi-channel, multi-carrier operating system.

The Android OS has a number of version releases, with the latest currently being the Android 4.0 (Ice Cream Sandwich). However, Android 2.3 Gingerbread still holds the most number of users based on statistics (as of 1st June 2012) [6].

C. Current Music Mobile Application Analysis.

Today, as the Android increases its popularity among smart phone users, Android developers are on the rise to create smart and innovative mobile applications for the mass. Various genres of mobile applications are made available in the Android market, ranging from navigation, utilization, entertainment, education and many more. As of October 2011, it is reported that there are more than 500,000 applications available for the Android OS [7], and the estimated number of applications downloaded from the Android Market as of December 2011 exceeded 10 billion [8].

Among the subject of interests among Android developers are music instrument digital simulators. Mobile applications that simulate musical instruments such as piano, guitars, or drums, has been one of the most popular applications to be downloaded by users. Due to the quick responsiveness of touch screens and touch sensitivity, music instruments are suitable to be projected as mobile applications, bringing realism closer to the user's fingers.

Gamelan, particularly the 'Bonang' and the "Saron", are percussive instruments. This means they are static, and will emit sound when hit, in this case, by mallets. Unlike the guitar or violin, there is no technical complexity to playing the instrument. In other words, from the mobile application point of view, users will only need to touch the specific parts, and it will play the sound.

Currently, there is a very small number of mobile application developers focusing to emulate the gamelan. One of the few, the "Gamelan", by ganzogo, is an Android application that allows users to play the "Peking". The application reaches its aim to simulate one of the gamelan instruments. The audio imitates the gamelan's tone well. Unfortunately, it has lag issues and some of the keys do not respond well.

"Gamelan DJ" by kowplink, is an Android application that combines both traditional and modern DJ music. The concept is to mix beats and drum patterns with harmonies and melodies of the Gamelan. However, the application only lets the player use only one type of Gamelan instrument which is the Saron. Additionally, the involvement of modern influences sways the direction of Gamelan being retained in its original form, as the additional features are deemed unnecessary.

The "Gamelan", by masagi studio is a similar application made for iOS. It works quite similar to the above application, "gamelan", by ganzogo. However, it is much better in terms of design, where a 3d-graphical interface is displayed. It also features key labeling, which is of great use for players who require notes and guide to play.

Alternatively, analysis should not be constrained on gamelan mobile applications only. We should look into similar music applications around the market to gather more input and ideas. One of the best piano applications in the mobile market is the "Virtuoso Piano Free 2". Developed for the iOS, it is praised for its simplistic design. The keys of the piano are represented well in a 3D graphical format. The interface is nicely arranged for the users to play, and it is touch-responsiveness works effectively. The application allows an option for the keys on the piano to be labeled with notes for users to easily understand it more.

D. Basics of Learning Gamelan Music.

Gamelan instruments are mostly metallophone and gong type instruments which produce tones when struck with mallets. Additionally, other types of percussion instruments included in a regular gamelan ensemble are: a wooden xylophone (gambang), and a set of two headed drums (kendhang) played with the palm and fingers. Non-percussion instruments include the rebab, a two-stringed bowed instrument, a plucked zither-type instrument (celempung or siter), and a bamboo flute (seruling). A male or female singer, and a male chorus of two or three singers may also participate in a gamelan ensemble.

Traditionally, one learns to play gamelan aurally, in which one perceives the music and progressions by ear. This is a learning process in which one has to spend much time listening to and observing a gamelan performance. Several musical notations have been introduced and experimented with since the end of the nineteenth century. In present-day Java, cipher notation is commonly used as a teaching device and for analyses. Below are the traditional names of the pitches and their cipher equivalents.

Most gamelan instruments are tuned to definite pitches corresponding to two kinds of tuning systems, which are the: five-tone slendro and seven-tone pelog. Therefore, a complete gamelan set of forty to sixty instruments are actually double sets of slendro and pelog gamelan, although they are never played simultaneously.

Each tuning system is characterized by its intervallic patterns. In slendro, the five intervals consist of short and medium steps. The difference between the two intervals in slendro is so small that they are often inaccurately described as equal or nearly equal intervals.

In pelog, although it has seven pitches per octave, sets of five pitch positions are used and combined. Thus, the pelog intervals consist of small, medium and large steps. Pelog is also pentatonic, but consists of three basic five-pitch scales. Unlike slendro, narrow and wide intervals in each of these scales are very apparent.

In a Gamelan ensemble, the Saron, which has thick keys, provides the high octave of the whole orchestration. There are different types of Saron, which includes the saron barung, and peking. The Saron barung is played with wooden mallets, while the saron peking is played with mallets made of horn. These instruments are played with the right hand holding the mallet slanting a little to the right to produce a full sound. The left hand acts as a damper by grasping the key with the thumb and forefinger. The damping of the key must be done at the same time the right hand strikes the next key. This helps prevent the key struck before to interfere with the next key.

Bonang are designed to have two rows of horizontal gong-kettles, placed open side down, on cords stretched over a rectangular wooden-frame. The gong-kettles are made of bronze. The bonang is played with two long sticks padded with cord at the striking end. Playing the bonang may be a bit tricky as the pattern of the arms will interchange at the middle. The bonang is considered

important in leading all the other instruments in the ensemble.

III. METHODOLOGY

A. Project Methodology.

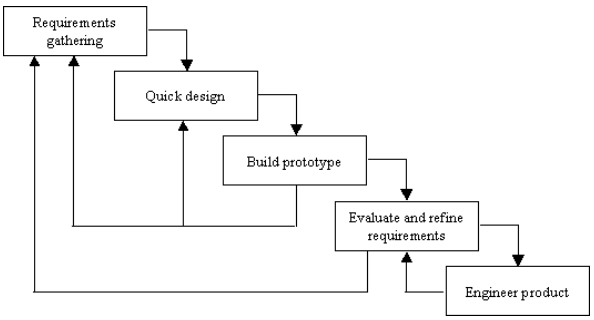

Figure 1. Prototyping Model

The method used to conduct the project is by implementing the prototyping model. For this project, the biggest aim is to create a virtual 'Bonang' and 'Saron' digital instrument. However, this may be prone to changes as the project progresses. There are ideas to add other instruments in the gamelan ensemble as well, or even add recording interfaces to further upgrade its usability, given there is enough time before the end of the timeframe. Due to the uncertainty of this, the prototyping model shall be implemented.

In a nutshell, requirements will be determined in the initial phase. This would be achieved by gathering data from potential users, conducting interviews, analyzing literature reviews and understanding the current technological trend of similar mobile applications. These data will then fuel the planning stage of the project, where the storyboard, wireframe and flowchart will be sketched. Soon after, full implementation and development will run, where most of the main activities such as recording, coding and programming will be done. When the prototype is ready, it may be given to test users, where their feedback will be taken and analyzed. This will benefit the progress well as it ensures the project's functionality and usability goes in lieu with the objectives, or even more, to improve from the original vision. Corrections can be made early as the project progresses, lowering potential risks. Based on the capability of the project progress with the time constraint, there may also be a chance to add extra characteristics to the product. Due to the limited time, the prototyping model is a suitable choice to work straight-forward without spanning a long period of time.

B. Tools.

The Virtual Gamelan will be running on the Android OS, there are two basic tools needed to develop a mobile application on the Android platform which is; the mobile device to run the mobile application, and the toolkit needed to develop the mobile application.

The application is tested on the Samsung Galaxy Tab 7.7 running on the latest Android 4.0.4. This tablet is a suitable choice for the application to be hosted on, as its large screen resolution of 1280x800 makes it easier for the instruments to be played. It is also one of the most reliable android devices currently popular among tablet users. It is a benchmark for Android tablets as compared to other tablets.

The development of the Virtual Gamelan is done using Eclipse, a multi-language software development environment comprising an integrated development environment (IDE). Program will be written mostly in Java. The Eclipse SDK is a free and open-source software. It also includes the Eclipse Java development tools (JDT), which offers an IDE with a built-in incremental Java compiler and a full model of the Java source files. This allows for advanced code analysis. Eclipse is found to be fairly convenient for mobile application developers, and is one of the best SDKs around, making it a good choice for the application to be developed on.

The virtual gamelan uses original audio files from the real instruments to retain the Virtual Gamelan in its original form. Hence, an audio recording device was needed to gather the audio files. For this project, the Zoom H4N, a professional stereo microphone was used to record. Provided with the right circumstances; setting up a room with no noises, the Zoom H4N can record the audio files clearly. These audio files will then be implemented into the application.

A camera was also needed to capture photographs of the Gamelan instruments. These photos are then edited to suit into graphics suitable for the application. These are used as the playing mat for users to play the instruments on. The camera used was the Canon EOS 5D Mark ii.

IV. RESULTS AND DISCUSSION

A. *Storyboard, Flowchart and Wireframe.*

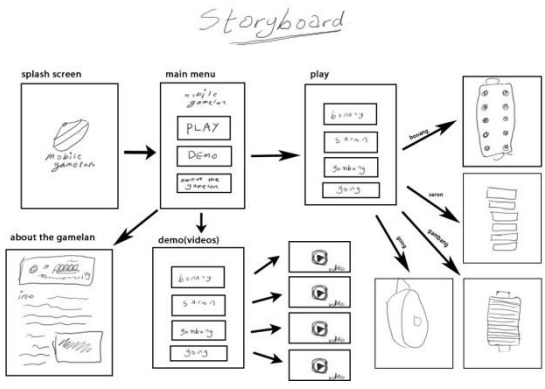

Figure 2. Storyboard of software

Figure 2 shows the storyboard of the software. When the user initiates the application, firstly, the application will show the splash screen for about three seconds. The splash screen will display the application's logo, and a short Gamelan melody will be played to immerse the users.

Then, the application's main menu will be shown. This is where the users will be given the options to choose between its three modules: "About the Gamelan", "Demonstrations", and "Play the instruments".

If the user presses “About the Gamelan”, the user will be shown information about Gamelan music. Information displayed will be about what the Gamelan really is, how it is played, its history, and samples of Gamelan music in audio or video form. This section translates the application to be an educational tool about Gamelan, for it opens a lot of introduction knowledge for interested users.

The “Demonstration” section lets the user see videos of how these Gamelan instruments are played. For each playable instrument featured in the application, there will be an instructional video of how these instruments are struck and how it sounds like. It would be helpful for beginners learning to play the Gamelan instruments.

The “Play” section brings its users to the application’s main feature, which is playing the instruments itself. By choosing either Bonang or Saron, users will be led to the display of the instruments. They will play the instruments by using their finger touch on the graphical representation as the input. Once touched, a sound will immediately be generated based on what the user has pressed as the output.

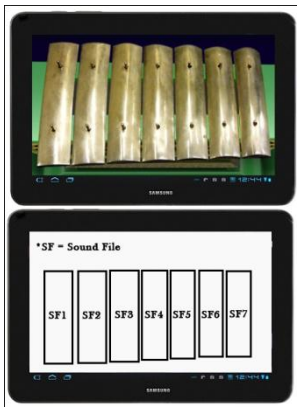

Figure 3. Draft of prototype functionality.

To make the application function accordingly, where the fingers touch the notes and the sound plays, a draft of how its functionality works was fingerprinted. A button will be placed on the back interface, where each area will have its separate sound file. The graphical interface of the instrument will then be layered on the topmost part to function as the user interface.

An added feature will be key labeling. Key labeling is an option which can be enabled by the user. It will label the instruments with notes which help beginners learning which key is which. It will also help users play according to scores, provided they are both in the same tuning and scale.

B. Software Prototype.

Figure 4 below shows the Android Home menu where the Virtual Gamelan application icon is visible for user to click on if he wishes to initiate the program.

Figure 4. Home screen with application icon

As soon as the icon is clicked, the program starts with a three second splash screen displaying the application’s logo and title. A short melody of the Gamelan also accompanies the splash screen.

Figure 5 shows the main menu of the application. The user is given three choices: “About the Gamelan”, “Demo” and “Play.

Figure 5. Main menu of application

Should the user presses on “About the Gamelan”, the user will then be led to another sub-menu which displays three other options: “About Gamelan music”, “History” and “Live Videos”.

The first main module, “About the Gamelan” features descriptions about Gamelan and Gamelan music in general. “About Gamelan music” explains what Gamelan is, its origins, the instruments in an ensemble, and other relevant information about it. The “History” page focuses about the Gamelan’s rich history. “Live Videos” lets the user sees how a Gamelan ensemble plays in video form.

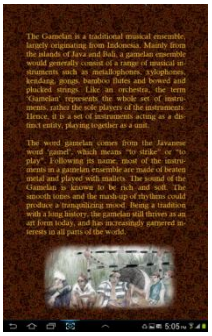

Figure 6. “About the Gamelan” screenshot

The second main module, "Demo", is a compilation of instructional videos about the Gamelan instruments. The videos being featured are in coherence with the playable instruments in the application, which are the Bonang, Saron, Gambang and Gong. This section serves as a learning tool for beginners to know how to play the instrument, and acts as a tutorial for first time users to go through before playing.

The third main module is the "Play" section. This is the main attraction of the application where the user is allowed to play the Gamelan instruments. After clicking "Play", the user is led to its sub-menu, which is a list of available Gamelan instruments to play on.

Figure 7 & 8 shows the "Saron" screen. When the user touches the metallic bars, its respective sound note will emit on touch. To add to the realism, it is multi-touch. The Saron also has a different way of playing. After a note has been struck, the players would hold the metallic bar's edge to stop the note in order to avoid it from sustaining, where it will meddle with other notes struck afterwards. Hence, in the application, the user also has the ability to stop the notes by touching the low edge of the metallic bar. At the bottom of the screen is the option to enable note display. If the user chooses to enable it, a note will be displayed on each metallic bar. This makes it easier for the user to identify the notes.

Figure 7. Saron screenshot

Figure 8. Saron screenshot after notes are enabled.

Figure 9 below shows the "Bonang" screen. Practically, the method of playing the Bonang needs the user to use two hammers, where it is played simultaneously at times. Hence, the multi-touch is fully utilized in this implementation. Note display is available as well for users.

Figure 9. Bonang screenshot

C. User Testing Results.

To evaluate how well the project is done, user testing was done on potential users. A total of 15 correspondents were given the application, where five where Gamelan musicians. The rest were usual mobile device users.

To test the usability of the application, a System Usability Scale (SUS) evaluation was conducted. The SUS is a usability test with ten simple questions that gives a global view of subjective assessments of usability.

Testers was given the application either through download, or through tests on the tablet showed to them. They were given the chance to play around with the software without any form of guidance. After testing, they were given a questionnaire with ten questions, vital to a SUS evaluation.

The SUS evaluation resulted in a SUS average score of 86.6, which is quite satisfactory. The results are shown in figure below. The number beside each question bar is the average SUS score for the total the number of correspondents on the respective question.

Figure 10. SUS Results

Besides the SUS evaluation, user comments were gathered while the app was in use and after use. Overall, comments were positive and complimented the quality of the music instruments in terms of sound and graphics. Navigation through the menus was easy and direct. Most users were satisfied with their experience with the application. Constructive criticism included that the app would be better with the whole set of Gamelan instruments finished. The responsiveness would sometime have little latency. However, this may contribute from the user's mobile devices themselves. Additional comments were of that they wished for more extensive features, such as the ability to record the playing.

V. CONCLUSION AND RECOMMENDATIONS

The release of the mobile application will meet the demands of musicians interested to play Gamelan music with ease. Furthermore, it leaves the door open for usual mobile device users to enjoy the musical instrument and to learn something new from the historical art form.

As per the objectives of the project, the software has met the said aims and objectives. After user testing with potential users, it has proven to satisfy musicians. It has also exposed Gamelan music to people unaware of its existence. The Gamelan instruments were successfully emulated as a digital form for the mobile device market. Moreover, it has utilized multi-touch capabilities of Android devices. User experiences have also been evaluated where it has showed positive results.

However, the project will still be left open for further development. It is planned for the application to still continue developing. Added features will bring in other Gamelan instruments, and to aim to fully enhance the platform's capabilities in the future. It will also be released on the market globally to be distributed worldwide for users to download from. It is in its vision to bring Gamelan music attention from around the world, and with today's technology, it widens the possibility to achieve it.

ACKNOWLEDGMENT

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