



**Utilizing Motion Sensors in Creating a Movement-Based Violin
Simulator Application in Android**

UNDERGRADUATE THESIS

**Submitted as one of the requirements to
obtain
Sarjana Komputer (S.Kom.)**

**By:
FELICIA LIMIARDO
001201900036**

**FACULTY OF COMPUTING
INFORMATION TECHNOLOGY STUDY PROGRAM
CIKARANG
MARCH, 2023**

PANEL OF EXAMINER APPROVAL

The Panel of Examiners declare that the undergraduate thesis entitled **Utilizing Motion Sensors in Creating a Movement-Based Violin Simulator Application in Android** that was submitted by Felicia Limiaro majoring in Information Technology from the Faculty of Computing was assessed and approved to have passed the Oral Examination on 28th March 2023.

Panel of Examiner



.....
Rusdianto Roestam MSc., PhD.



.....
Tjong Wan Sen, S. T., M.T.



.....
Nur Hadisukmana M.Sc

STATEMENT OF ORIGINALITY

In my capacity as an active student of President University and as the author of the undergraduate thesis/final project/business plan (underline that applies) stated below:

Name : Felicia Limiardo
Student ID number : 001201900036
Study Program : Information Technology
Faculty : Computing

I hereby declare that my undergraduate thesis/final project/business plan entitled "**Utilizing Motion Sensors in Creating a Movement-Based Violin Simulator Application in Android**" is, to the best of my knowledge and belief, an original piece of work based on sound academic principles. If there is any plagiarism, including but not limited to Artificial Intelligence plagiarism, is detected in this undergraduate thesis/final project/business plan, I am willing to be personally responsible for the consequences of these acts of plagiarism, and accept the sanctions against these acts in accordance with the rules and policies of President University.

I also declare that this work, either in whole or in part, has not been submitted to another university to obtain a degree.

Cikarang, 16 March 2023



(Felicia Limiardo)

SCIENTIFIC PUBLICATION APPROVAL FOR ACADEMIC INTEREST

As a student of the President University, I, the undersigned:

Name : Felicia Limiardo
Student ID number : 001201900036
Study program : Information Technology

for the purpose of development of science and technology, certify, and approve to give President University a non-exclusive royalty-free right upon my final report with the title:

Utilizing Motion Sensors in Creating a Movement-Based Violin Simulator Application in Android

With this non-exclusive royalty-free right, President University is entitled to converse, to convert, to manage in a database, to maintain, and to publish my final report. There are to be done with the obligation from President University to mention my name as the copyright owner of my final report.

This statement I made in truth.

Cikarang, 16 March 2023



(Felicia Limiardo)

ADVISOR'S APPROVAL FOR PUBLICATION

As a lecturer of the President University, I, the undersigned:

Advisor's Name : Nur Hadisukmana, M.Sc
NIDN : 0423076302
Study program : Information Technology
Faculty : Computing

declare that following thesis:

Title of undergraduate thesis : **Utilizing Motion Sensors in Creating a
Movement-Based Violin Simulator
Application in Android**
Undergraduate Thesis author : Felicia Limiardo
Student ID number : 001201900036

will be published in **journal / institution's repository / proceeding / unpublsh**

Cikarang, 16 March 2023



(Nur Hadisukmana, M.Sc)

Check finpro

ORIGINALITY REPORT

9%

SIMILARITY INDEX

8%

INTERNET SOURCES

3%

PUBLICATIONS

0%

STUDENT PAPERS

PRIMARY SOURCES

1	repository.president.ac.id Internet Source	2%
2	developer.android.com Internet Source	2%
3	www.coursehero.com Internet Source	1%
4	oliviachen2020.wixsite.com Internet Source	<1%
5	docand.com Internet Source	<1%
6	autopilot-project.eu Internet Source	<1%
7	apps.dtic.mil Internet Source	<1%
8	acikbilim.yok.gov.tr Internet Source	<1%
9	Kishori Sharan, Peter Späth. "Learn JavaFX 17", Springer Science and Business Media LLC, 2022	<1%

10

www.yamaha.com

Internet Source

<1 %

11

"Trends in Artificial Intelligence: PRICAI 2016 Workshops", Springer Science and Business Media LLC, 2017

Publication

<1 %

12

publications.lib.chalmers.se

Internet Source

<1 %

13

Roopesh Kevin Sungkur, Hansraj Bissessur, Krishna Camdoo. "SensorApp: the light at the end of the tunnel for visually impaired learners", Journal of Computers in Education, 2017

Publication

<1 %

14

www.mobile-phones.co.uk

Internet Source

<1 %

15

fenix.tecnico.ulisboa.pt

Internet Source

<1 %

16

www.diva-portal.org

Internet Source

<1 %

17

M. Samir Abou El-Seoud, Islam A. T. F. Taj-Eddin. "Chapter 1 Developing an Android Mobile Bluetooth Chat Messenger as an Interactive and Collaborative Learning Aid",

<1 %

Springer Science and Business Media LLC, 2017

Publication

18

www.techaheadcorp.com

Internet Source

<1 %

19

"Hybrid Artificial Intelligence Systems",
Springer Science and Business Media LLC,
2014

Publication

<1 %

20

Md. Elias Hossain, Arshadina Umara Najib,
Md. Zahidul Islam. "Combating Domestic
Violence during COVID-19 Pandemic in
Bangladesh: Using a Mobile Application
integrated with an Effective Solution", 2020
23rd International Conference on Computer
and Information Technology (ICCIT), 2020

Publication

<1 %

21

docshare02.docshare.tips

Internet Source

<1 %

22

freesound.org

Internet Source

<1 %

23

repozitorij.etfos.hr

Internet Source

<1 %

24

Lecture Notes in Computer Science, 2009.

Publication

<1 %

25

repmus.ircam.fr

Internet Source

<1 %

26 "Network Science and Cybersecurity",
Springer Nature, 2014
Publication

<1 %

27 science.rsu.lv
Internet Source

<1 %

28 vdoc.pub
Internet Source

<1 %

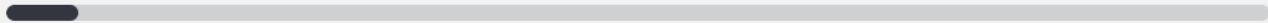
Exclude quotes Off

Exclude matches Off

Exclude bibliography On

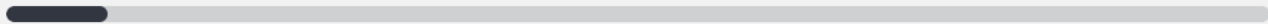
Stats

Average Perplexity Score: 56.450



A document's perplexity is a measurement of the randomness of the text

Burstiness Score: 79.438



A document's burstiness is a measurement of the variation in perplexity

Your sentence with the highest perplexity, *"Playing music not only involves"*, has a perplexity of: 501

ABSTRACT

Playing music is good for the brain because it involves multiple areas of the brain simultaneously, such as the visual, motor, and auditory cortices. Regularly exercising these areas can lead to stronger problem-solving skills, higher cognitive abilities, and better memory functions.

However, as a beginner, learning to play musical instruments can be pretty intimidating. Not only are the instruments expensive, but it also requires a high amount of cognitive load to learn to play as well as reading the music sheet. The violin is an instrument known to be one of the hardest to learn because it places a heavy burden physically and mentally. Because of this, a lot of people have started to turn to mobile musical instrument simulators as a starting point, due to its convenience, practicality, and affordability. But the simulators present a new set of challenges in that they keep the users confined to the screen, which is not ideal for instruments like violin where movement is a big part of the playing experience. This violin simulator was developed with the goal of facilitating learning and for users to develop muscle memory. The hope is that by offloading the cognitive load to the body, users will have an easier time to learn.

In this application, users are able to play normal and accidental notes across two octaves (the 4th and 5th) and with 3 common musical techniques: Pizzicato, Staccato, and Legato. To start playing, users can click on one of the 8 buttons on screen and move

the phone left and right. To change octaves, users can move the phone up and down. To play accidental notes, users can hold the phone in landscape position.

Motion sensors - specifically accelerometer and gyroscope - were used in the development of this application. Because the accelerometer can only detect the acceleration value of the phone, users would need to move the phone rather quickly in order for the application to work.

Nevertheless, the initial testing stage results in a very positive outcome. Every feature that was tested worked as expected. However, it would work better with an additional supporting board attached to the phone, which is not in scope of this project.

This project is still very basic in nature and there can be a lot more features included for future development.

TABLE OF CONTENTS

Table of Contents

PANEL OF EXAMINER APPROVAL	iv
STATEMENT OF ORIGINALITY	v
SCIENTIFIC PUBLICATION APPROVAL FOR ACADEMIC INTEREST.....	vi
ADVISOR’S APPROVAL FOR PUBLICATION.....	vii
ABSTRACT.....	viii
TABLE OF CONTENTS	x
LIST OF TABLES	xiii
LIST OF FIGURES	xiv
INTRODUCTION.....	17
1.1 Background	17
1.2 Problem Statement	20
1.3 Research Objective.....	21
1.4 Scope and Limit	22
1.5 Methodology	22
1.6 Final Project Outline	23
LITERATURE STUDY.....	25
2.1 Violin and its workings	25
2.2 Android Studio	27

2.3	Sensors	28
2.3.1	Motion sensors.....	28
2.4	Simulators.....	32
2.4.1	Mobile Musical Instrument Simulator.....	35
2.5	Embodied or Situated Cognition.....	37
2.6	Related Work.....	42
2.6.1	Motion Vox.....	42
2.6.2	Music from Motion	43
2.7	Comparison Overview.....	44
SYSTEM ANALYSIS		46
3.1	System Overview	46
3.2	System Requirements	46
3.3	Software Requirements	46
3.4	Use Case Diagram.....	47
3.5	Use Case Narrative.....	47
3.6	Activity Diagram.....	52
SYSTEM DESIGN.....		54
4.1	User Interface Design.....	54
SYSTEM IMPLEMENTATION.....		58
5.1	User Interface Implementation.....	58
5.2	System Implementation.....	59

SYSTEM TESTING	74
6.1 Testing Device Specifications	74
6.2 Testing Scenario	75
CONCLUSION AND FUTURE WORKS.....	78
7.1 Conclusion.....	78
7.2 Future Work	79
REFERENCES.....	80

LIST OF TABLES

Table 2.1 Comparison overview of my music app with Motion Vox and the MIDI controller	44
Table 3.1 Use case narrative of playing a normal C note	48
Table 3.2 Use case narrative of playing a C note in Pizzicato.....	48
Table 3.3 Use case narrative of playing a C note in Staccato.....	49
Table 3.4 Use case narrative of playing a C and D note in Legato.....	50
Table 3.5 Use case narrative of playing a C# note	51
Table 6.1 Testing device specifications	74
Table 6.2 Emulator specifications.....	75
Table 6.3 Testing scenarios for the features of the music app.....	75

LIST OF FIGURES

Figure 1.1 MusicAid, a touchscreen controller for the deaf used to compose digital music	18
Figure 1.2 The brain areas involved in perceiving and producing music	19
Figure 1.3 MRI scans of a musician’s brain showing greater cortical thickness in the auditory, motor, and frontal cortices.....	19
Figure 1.4 Lean UX methodology	23
Figure 2.1 Parts of a violin.....	26
Figure 2.2 Acceleration applied to a device in relation to the force applied to the sensor	30
Figure 2.3 Acceleration of a device influenced by gravity	30
Figure 2.4 Coordinate system used by the motion sensors	31
Figure 2.5 A static image of the virtual audience	34
Figure 2.6 A static image of the virtual judges panel	34
Figure 2.7 GarageBand showing multiple instruments audio to edit at once	35
Figure 2.8 Perfect Piano app in waterfall mode showing user how to play the song Traumerei by Robert Schumman	36
Figure 2.9 A diagram of the bubble of reason when facing a complex situation, where the consciousness draws on information from the environment to create a representation model that they can infer and reason on.....	38
Figure 2.10 Components of the BigDog robot created by the Boston Dynamics.....	39
Figure 2.11 A simplified flowchart of attentional redistribution in the brain based on cognitive demands	41
Figure 2.12 A screenshot of Motion Vox being used	42

Figure 2.13 The first prototype of the controller before the wiring and breadboard is attached	43
Figure 2.14 The second prototype of the controller, viewed from the top	43
Figure 3.1 Use case diagram of the application	47
Figure 3.2 Activity diagram of a typical user interaction	53
Figure 4.1 User interface of the application.....	55
Figure 4.2 The recommended way to hold the phone with a protective strap viewed from the front	56
Figure 4.3 The ideal way of holding the phone (black) with a supportive board (green) and a protective strap (blue) viewed from above	56
Figure 4.4 How to hold the phone with two hands without the supporting board or protective strap.....	57
Figure 5.1 User Interface of the main activity	58
Figure 5.2 The accelerometer listener passing filtered values from the sensor to the `onTranslation` method in MainActivity	59
Figure 5.3 The gyroscope listener passing values from the sensor to the `onRotation` method in the MainActivity	60
Figure 5.4 The `onTranslation` method checking the current orientation of the phone	60
Figure 5.5 Determining the current orientation of the phone every time it changes. ..	61
Figure 5.6 The `portrait` method checking the movement of the phone	62
Figure 5.7 The `landscape` method checking the movement of the phone	63
Figure 5.8 The `reverseLandscape` method checking the movement of the phone	63
Figure 5.9 The simplified version of the coordinate system for each orientation	64

Figure 5.10 The `onRotation` method checking the rotation of the phone and unregisters or registers the accelerometer accordingly	65
Figure 5.11 The code for the C button.....	66
Figure 5.12 The `moving_method` determines the current movement status of the phone and the `sharp_method` determines the current audio status depending on the current orientation of the phone	67
Figure 5.13 The list of all audio files used in this program	68
Figure 5.14 Audios of the 4th octave being loaded to soundPool under the `onCreate` method.....	69
Figure 5.15 The flowchart for this application	70
Figure 5.16 Waveforms of C4 and C5 being edited to be more stable and equal in volume and pitch.....	71
Figure 5.17 Waveforms of C4, C5, and C6 being edited.....	72
Figure 5.18 Two waveforms of C5 audio sample with a zero crossing meeting point	72
Figure 5.19 Audio tracks of C5 overlapping while editing	73