

**CHEMISTRY LABORATORIUM SIMULATION BASED ON
AUGMENTED REALITY**

FINAL PROJECT REPORT

Prepared by:

Filisya Yuditha Caridad Clemente

15013043



INFORMATICS ENGINEERING DEPARTMENT

FACULTY OF ENGINEERING

UNIVERSITAS KATOLIK DE LA SALLE

MANADO

2019

**CHEMISTRY LABORATORIUM SIMULATION BASED ON
AUGMENTED REALITY**

FINAL PROJECT REPORT

Presented as a Partial Fulfillment of the Requirements Obtaining
Sarjana Teknik Degree in Informatics Engineering Department

Prepared By:

Filisya Yuditha Caridad Clemente

150130143



**INFORMATICS ENGINEERING DEPARTMENT
FACULTY OF ENGINEERING
UNIVERSITAS KATOLIK DE LA SALLE
MANADO
2019**

STATEMENT LETTER

This statement letter is signed by:

Name : Filisya Yuditha Caridad Clemente
NIM : 15013043
Birthplace/Birthdate : Tomohon/09 Juni 1999
Faculty/Program Study : Engineering/Informatics Engineering

States that the Thesis Report and Application entitled "**Chemistry Laboratorium Simulator Based on Augmented Reality**" was made and is a true creation and work by the author and was not written and made by others except for the quotations mentioned in the sources used in the thesis report.

Therefore, this letter was truthfully and honestly made by the author. However, if this statement is incorrect then the author is willing to receive academic sanctions as set by the Faculty, in the form of cancelling the results of both the author's Thesis Report and Application.

Manado, 29 Juni 2019

Stated by,



Filisya Yuditha Caridad Clemente

Approved by,

Supervisor I

Ir. Rila Mandala, M.Eng., Ph.D

Supervisor II

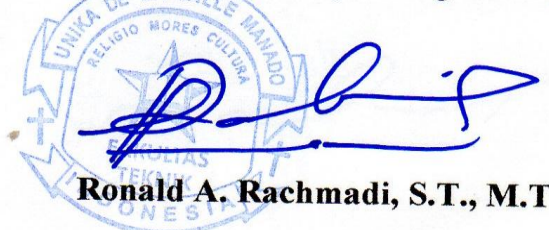
Thomas Suwanto, S.Kom, M.Mm

Approved by,

Head of the Program Study

Vivie D. Kumenap, S.T., M.Cs

Dean of the Faculty of Engineering



Ronald A. Rachmadi, S.T., M.T



**UNIVERSITAS KATOLIK DE LA SALLE
MANADO – INDONESIA**

Name : Filisya Yuditha Caridad Clemente
NIM : 15013043
Faculty : Engineering
Program Study : Informatics Engineering
Title of Final Project : Chemistry Laboratorium Simulation Based on
Augmented Reality
Supervisor I : Ir. Rila Mandala, M.Eng., Ph.D
Supervisor II : Thomas Suwanto, S.Kom., M.Mm

Approved by,

Manado, 29 Juni 2019

Supervisor I

Ir. Rila Mandala, M.Eng., Ph.D

Supervisor II

Thomas Suwanto, S.Kom., M.Mm

Approved by,

Head of the Program Study

Vivie D. Kumenap, S.T., M.Cs

Dean of the Faculty of Engineering

Ronald A. Rachmadi, S.T., M.T

ABSTRACT

Technology is already used through classrooms as educators and developers create more and more products designed to enhance education. Adaptive learning software are quickly replacing the role of textbooks in classrooms and students today are tackling subjects with the aid and help from tailor-made computer programs that assist their needs. The role of technology is also helping Science, it is used in different aspects such as conducting researches, analytical problem solving and experiments. Chemistry, a subject that requires a lot of experiments, and within these different experiments, it uses chemicals that may harm and risk students that can cause permanent damages and accidents.

As given from the problem above, the author thought of providing a solution by creating an application that will be a help for students to conduct experiments without harming themselves entitled "Chemistry Laboratory Simulator Based on Augmented Reality". With augmented reality, it will serve as a direct manipulation user interface and will be the best way to engage the students into learning. Augmented Reality also teaches complex concepts to the students, elevates them to engage into participating in classes, provides practical knowledge and it provides access to learning

Therefore, the application is given specifically to Senior High School (SMA) students in providing knowledge and learning about the concepts and process of the compounds in Chemistry with definitions and simulations by using Augmented Reality markers and three-dimensional graphics to enhance the education of Senior High School (SMA) students.

Keywords: Chemistry Education, Technology, Science, Augmented Reality.

ABSTRAK

Teknologi telah digunakan di dalam kelas oleh para pendidik, karena pengembang telah menciptakan berbagai produk yang dirancang untuk meningkatkan pendidikan. Perangkat lunak pembelajaran adaptif saat ini telah menggantikan peran buku tulis di kelas. Saat ini para siswa terbantu dalam beberapa mata pelajaran dengan adanya aplikasi komputer khusus dibuat untuk membantu memenuhi kebutuhan mereka. Peranan teknologi saat ini juga untuk membantu ilmu pengetahuan yang digunakan dalam berbagai aspek seperti melakukan penelitian, pemecahan masalah analisis dan eksperimen. Kimia, salah satu mata pelajaran yang membutuhkan banyak percobaan dalam berbagai eksperimen yang berbeda dan sering menggunakan bahan kimia yang berbahaya serta bisa mengakibatkan kecelakaan yang menyebabkan kerusakan permanen pada siswa.

Berdasarkan permasalahan diatas, penulis bermaksud memberikan solusi dengan membuat sebuah aplikasi yang dapat membantu siswa dalam melakukan eksperimen tanpa membahayakan diri mereka sendiri yang berjudul “Chemistry Laboratorium Simulation based on Augmented Reality”. Augmented Reality berfungsi sebagai antarmuka pengguna yang akan berinteraksi langsung dengan para siswa, mendorong mereka untuk terlibat melalui partisipasi mereka dalam kelas, menyediakan pengetahuan praktis dan akses belajar.

Maka aplikasi ini secara khusus diberikan kepada siswa Sekolah Menengah Atas (SMA) dalam memberikan pengetahuan dan pembelajaran tentang konsep dan proses senyawa dalam Kimia dengan definisi dan simulasi menggunakan penanda Augmented Reality dan grafik tiga dimensi bisa meningkatkan pendidikan siswa Sekolah Menengah Atas (SMA).

Kata Kunci: *Pelajaran Kimia, Teknologi, Ilmu Pengetahuan, Augmented Reality.*

ACKNOWLEDGEMENTS

First and foremost, I would like to express my sincere gratitude to Almighty God for his grace and guidance for giving strength and the upmost blessings to the author in the completion of the Thesis Report entitled "Chemistry Laboratorium Simulator Based on Augmented Reality". The process of writing the Thesis Report was able to be completed because of the help and support of many people, therefore, the author would like to thank:

1. My beloved family, Mom, Dad, Fernando and Farrah Fae who were always there to provide the outmost support, motivations and prayers in order for the author to complete the Thesis Report.
2. Prof. Dr. Johanis Ohoitumur, MSC as the Rector of Universitas Katolik De La Salle Manado.
3. Sir Ronald A. Rachmadi, S.T., M.T. as the Dean of the Faculty of Engineering in Universitas Katolik De La Salle Manado.
4. Ma'am Vivie D. Kumenap, S.T., M.Cs as the Head of the Program Study Informatics Engineering of Universitas Katolik De La Salle Manado.
5. Sir Michael Sumampouw, S.T., M.T. as the author's academic advisor.
6. Ir. Rila Mandala, M.Eng., as the author's First Supervisor who provides advices and guidance throughout the development of the Thesis Project.
7. Sir Thomas Suwanto, S.Kom, M.Mm as the author's Second Supervisor who provides advices, guidance and assistance throughout the development of the Thesis Project.
8. My best friends, Louisa Lohonauman, Meliana Kaseger, Christi Onibala, Meylan Wongkar, Lifeindo Kountur, Jaya Saleh, Kevin Pinontoan, Evander Kristalino, Rizky Tulandi, Yeremia Wurangian, Calvin Leonard and many more people that are not mentioned one by one who had assisted, prayed, supported and motivated the author.

The author certainly realizes that this Thesis Report is far from perfect and there are still errors, corrections and shortcomings. For this reason, criticism and suggestions from the readers are acknowledged to help the author correct the mistakes and create this report into a better one. Hopefully this report can be useful for all the readers.

Manado, June 2019

The Author

TABLE OF CONTENTS

STATEMENT LETTER	ii
CONFIRMATION LETTER	iii
ABSTRACT	ivi
ABSTRAK	v
ACKNOWLEDGEMENTS	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF APPENDIXES	xi
CHAPTER I - INTRODUCTION.....	1
1.1. Background	1
1.2. Problem	2
1.3. Objectives of the Research.....	2
1.4. Limitations	2
1.5. Benefits of the Research.....	3
1.6. Research Methods	3
1.7. Writing Systematics	4
CHAPTER II – LITERATURE REVIEW.....	6
2.1 Multimedia	6
2.2 Laboratorium Simulation	6
2.3 Chemistry	6
2.3.1. Elements	7
2.3.2. Compounds.....	7
2.3.2.1. Ionic Compounds.....	8
2.3.3. Physical Change	10
2.3.4. Chemical Change.....	10
2.4 Augmented Reality.....	11
2.4.1. Markerless Augmented Reality	12
2.4.2. Marker Augmented Reality	13
2.4 SketchUp.....	14
2.6 Blender	14
2.7 Unity 3D.....	14
2.8 Vuforia Engine: Developer Portal.....	15
2.9 Research Methodology.....	15
2.9.1. Multimedia Development Life Cycle	15
2.9.2. Qualitative Research Approach	16
2.10 Storyboard	16
2.11 Flowchart	17
CHAPTER III - ANALYSIS	19
3.1 Analyzing Needs	19
3.1.1. Review of Related Works.....	19
3.1.2. Application Selection Criteria	19

3.1.3. Comparison of Similar Applications	25
3.1.4. User Identification	31
3.1.5. Analyzing and Identifying of the Problem	31
3.1.6. Limitations and Needs of the Application	32
3.1.7. Risk Management	32
3.2 Cost Analysis	33
3.3 Content Analysis	34
3.4 Market Analysis	34
3.5 Technology Analysis.....	34
3.5.1. Technic	35
3.5.2. Media Distribution.....	35
3.5.3. Skills Needed	36
3.6 Create Content Outline.....	36
3.6.1. Definition of the Application.....	36
3.6.2. Content Outline.....	36
3.7 Position Sales and Marketing.....	37
3.8 Create Prototype on Paper.....	37
CHAPTER IV - DESIGN	38
4.1 Build screen Mock-ups	38
4.2 Design Content Maps	38
4.3 Storyboard	39
4.4 Flowchart	42
4.5 Vuforia Developer: Marker Database	43
CHAPTER V - IMPLEMENTATION.....	45
5.1 Finalize Story Script.....	45
5.2 Application Interface.....	47
5.3 Graphic Arts	45
5.4 Produce Sound and Video	51
5.5 Technical Problems	51
5.6 Programming.....	52
CHAPTER VI – TESTING.....	62
6.1 Test Goal	62
6.2 Test Criteria.....	62
6.3 Test Case	62
6.4 Analysis of Test Results.....	63
6.5 Test Implementation.....	64
6.6 Prepare User Docs.....	70
CHAPTER VII – CONCLUSION AND RECOMMENDATIONS.....	71
7.1 Conclusion	71
7.2 Recommendations	71
REFERENCES.....	72
CURRICULUM VITAE	

LIST OF TABLES

Table 2.1	Branches of Chemistry.....	7
Table 2.2	Seven Ionic Binary Compounds	8
Table 2.3	Properties of Ionic Compounds.....	10
Table 2.4	Flowchart Symbols	17
Table 3.1	Usage Mechanics: Type of Application.....	25
Table 3.2	Usage Mechanics: Specification	25
Table 3.3	Usage Mechanics: Language	26
Table 3.4	Usage Mechanics: Originality.....	26
Table 3.5	Layout: Structure.....	27
Table 3.6	Layout: Graphics.....	27
Table 3.7	Features: Animation.....	27
Table 3.8	Features: Overall Features	28
Table 3.9	Advantages of Similar Applications	29
Table 3.10	Disadvantages of Similar Applications.....	30
Table 3.11	User Interview Questions.....	31
Table 3.12	Analyzation and Identification of the Problem.....	31
Table 3.13	Limitations and Needs	32
Table 3.14	List of Risks	32
Table 3.15	Content Analysis	34
Table 3.16	Hardware Specifications (Application).....	35
Table 3.17	Software Specifications.....	36
Table 4.1	Content Maps	38
Table 5.1	Graphic Arts.....	47
Table 5.2	Marker Designs	50
Table 5.3	Main Menu Script	52
Table 5.4	Data Target Explore IBC Menu	53
Table 5.5	Data Target Simulation Menu.....	55
Table 5.6	Event Handler	58
Table 6.1	Alpha Test Case	62
Table 6.2	Beta Test Case.....	63
Table 6.3	Implementation of the Application	64
Table 6.4	Marker Test A	66
Table 6.5	Marker Test B	67
Table 6.6	Marker Test C	68
Table 6.7	Application Testing.....	69

LIST OF FIGURES

Figure 2.1	SLAM Technology	12
Figure 2.2	QR Code Marker.....	13
Figure 2.3	Passive Marker.....	13
Figure 2.4	Active Marker	13
Figure 2.5	The Process of Making Multimedia	15
Figure 2.6	The Process of Making Multimedia	16
Figure 3.1	Arloon AR Chemistry Education (Page 1)	20
Figure 3.2	Arloon AR Chemistry Education (Page 2)	20
Figure 3.3	Arloon AR Chemistry Education (Page 3)	20
Figure 3.4	Arloon AR Chemistry Education (Page 4)	20
Figure 3.5	Softweb Solutions: AR Chemistry Lessons (Page 1)	21
Figure 3.6	Softweb Solutions: AR Chemistry Lessons (Page 2)	21
Figure 3.7	Softweb Solutions: AR Chemistry Lessons (Page 3)	22
Figure 3.8	Softweb Solutions: AR Chemistry Lessons (Page 4)	22
Figure 3.9	MyLab App for the HoloLens (Page 1).....	23
Figure 3.10	MyLab App for the HoloLens (Page 2).....	23
Figure 3.11	MyLab App for the HoloLens (Page 3).....	23
Figure 3.12	AR VR Molecules Editor (Page 1)	24
Figure 3.13	AR VR Molecules Editor (Page 2)	24
Figure 3.14	AR VR Molecules Editor (Page 3)	24
Figure 4.1	Main Menu	39
Figure 4.2	Explore IBC Menu.....	40
Figure 4.3	Simulation Menu	41
Figure 4.4	Flowchart	42
Figure 4.5	Marker Database	43
Figure 4.6	License Manager.....	44
Figure 4.7	License Key	44
Figure 5.1	Main Menu Interface	45
Figure 5.2	Explore IBC Menu Interface	46
Figure 5.3	Simulation Menu Interface	46
Figure 6.1	Menu of the Application.....	64
Figure 6.2	Marker and 3D Object Test	65
Figure 6.3	Animation Testing	65

LIST OF APPENDIXES

Appendix A	Formal Interview	A-1
Appendix B	User Acceptance Test	B-1
Appendix C	User Manual.....	C-1