

## TABLE OF CONTENTS

	Page
COVER PAGE	
FINAL ASSIGNMENT STATEMENT AND UPLOAD AGREEMENT	
APPROVAL BY THESIS SUPERVISORS	
APPROVAL BY THESIS EXAMINATION COMMITTEE	
ABSTRACT .....	.v
<i>ABSTRAK</i> .....	vi
PREFACE .....	vii
TABLE OF CONTENTS .....	ix
LIST OF FIGURES .....	xi
LIST OF TABLES .....	xiii
LIST OF APPENDIXES .....	xiv
CHAPTER I INTRODUCTION .....	16
1.1 Background .....	16
1.2 Aims and Objectives .....	16
1.3 Scope of the Research .....	17
1.4 Research Method .....	17
1.5 Thesis Structure .....	17
CHAPTER II THEORETICAL BASE .....	18
2.1 Convolution Neural Network .....	18
2.2 Deep Learning .....	20
2.3 TensorFlow .....	21
2.4 OpenCV .....	22
2.5 Model Evaluation Metrics .....	22
2.5.1 Confusion Matrix .....	23
2.5.2 Accuracy .....	24
2.5.3 Precision .....	24
2.5.4 Recall .....	24
2.5.5 F-1 Value .....	25
2.6 Sign Language MNIST Dataset .....	25
2.7 Author Made Dataset .....	26
CHAPTER III RESEARCH METHODOLOGY .....	27
3.1 System Description .....	27
3.2 Research Workflow .....	28
CHAPTER IV DESIGNING SIGN LANGUAGE CLASSIFIER .....	29

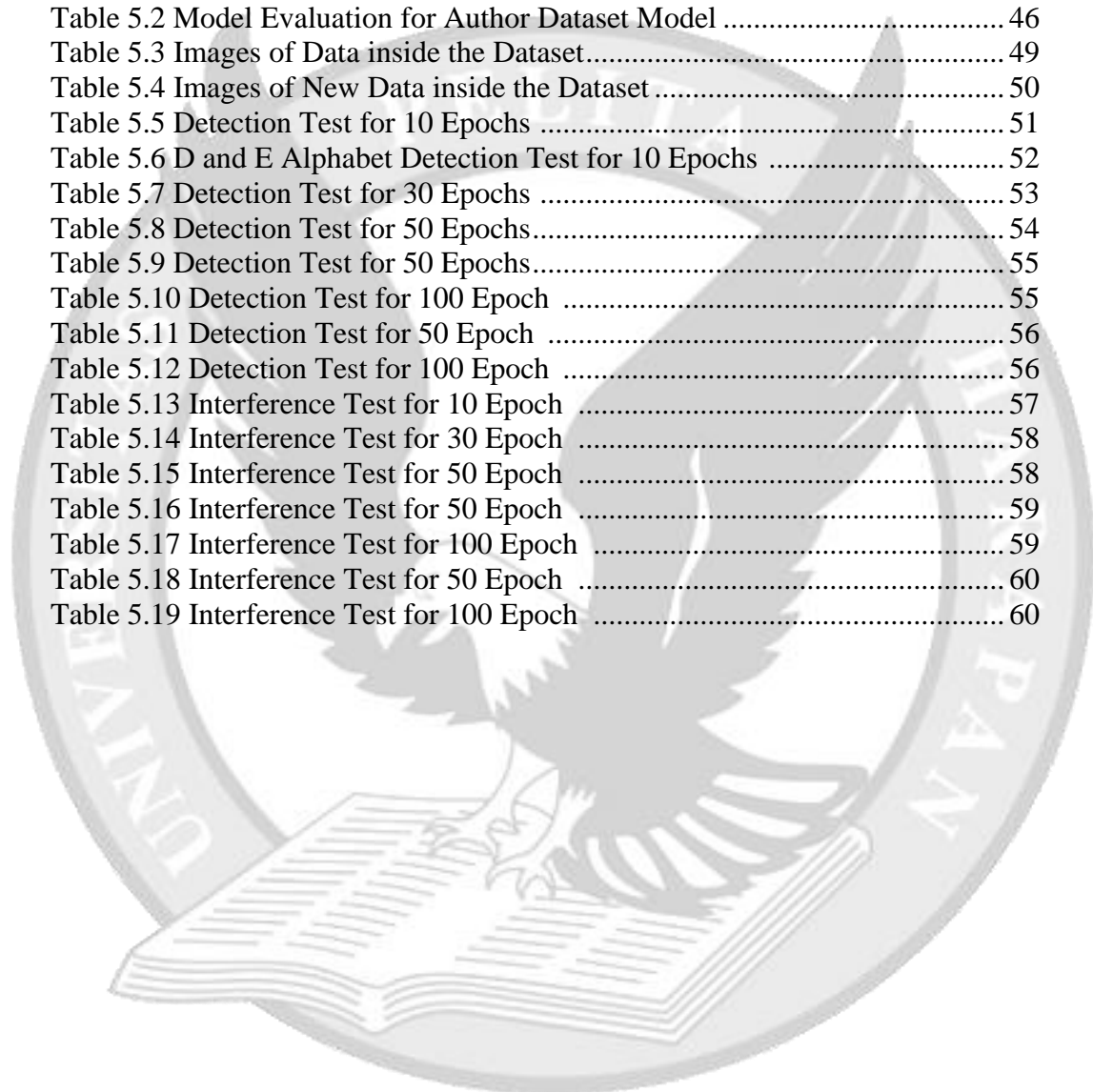
4.1	Build Machine Learning Model from the Sign Language MNIST Dataset .....	29
4.2	Implement Sign Language MNIST Dataset Model in OpenCV .....	34
4.3	Build Machine Learning Model from the Author Dataset Model .....	35
4.3	Implement Author Dataset Model in OpenCV .....	39
CHAPTER V RESULT AND ANALYSIS .....		41
5.1	Model Evaluation .....	41
5.1.1	Model Evaluation for Sign Language MNIST Dataset Model .....	41
5.1.2	Confusion Matrix for Sign Language MNIST Dataset Model .....	41
5.1.3	Model Evaluation for Author Dataset Model.....	43
5.1.4	Confusion Matrix for Author Dataset Model.....	43
5.1.5	Comparison of Loss and Accuracy Chart .....	45
5.1.6	Dataset Comparison of Sign Language MNIST Dataset and Author Dataset.....	45
5.2	Detection Test in OpenCV .....	47
5.2.1	Sign Language MNIST Dataset Model .....	47
5.2.2	Author Dataset Model .....	50
5.3	Testing with Interference Background .....	47
5.3.1	Sign Language MNIST Dataset Model .....	51
5.3.2	Author Dataset Model .....	54
CHAPTER VI CONCLUSION AND FUTURE OUTLOOK.....		55
6.1	Conclusion.....	55
6.2	Future Outlook .....	56
BIBLIOGRAPHY .....		57
APPENDIX.....		59

## LIST OF FIGURES

	Page
Figure 2.1 CNN Architecture .....	18
Figure 2.2 Convolution Operation .....	19
Figure 2.3 Pooling Operation .....	19
Figure 2.4 Classification Layer .....	20
Figure 2.5 Neural Network Architecture .....	20
Figure 2.6 Perceptron Process.....	21
Figure 2.7 TensorFlow Architecture.....	22
Figure 2.8 Pixel Value Inside Image.....	22
Figure 2.9 Binary Class Confusion Matrix .....	23
Figure 2.10 Multi Class Confusion Matrix .....	24
Figure 2.11 Human Gesture Represent in Dataset .....	25
Figure 3.2 Research Workflow Diagram .....	28
Figure 4.2 Take Label Value inside Dataset .....	29
Figure 4.3 Splitting Label and Pixel value in Train Dataset.....	31
Figure 4.4 Pixel Value in Images Variable .....	31
Figure 4.5 One Hot Encoding Pixel Value .....	31
Figure 4.6 Train-Test Split.....	32
Figure 4.7 Transformation Pixel Value into Binary Vector and Reshape .....	32
Figure 4.8 CNN Architecture for Model Training.....	33
Figure 4.9 Training Process .....	34
Figure 4.10 Function to Retrieve Label Value.....	34
Figure 4.11 Function to Determine the Label Value .....	34
Figure 4.12 Initialize Gesture Recognition in OpenCV.....	35
Figure 4.13 View Random Image Function.....	36
Figure 4.14 The Output of the Read Image Function .....	36
Figure 4.15 Initialize Directory and List the Training Class .....	36
Figure 4.16 Initialize Image Data Generator .....	37
Figure 4.17 CNN Architecture for Model Training .....	37
Figure 4.18 Initialize Model Compile and Fit.....	37
Figure 4.19 Function to Retrieve Model Prediction .....	39
Figure 4.20 Function to Run OpenCV .....	39
Figure 4.21 Initialize Gesture Recognition in OpenCV.....	40
Figure 5.1 Confusion Matrix for 10 Epoch.....	42
Figure 5.2 Confusion Matrix for 30 Epoch.....	42
Figure 5.3 Confusion Matrix for 50 Epoch.....	43
Figure 5.4 Confusion Matrix for 50 Epoch.....	44
Figure 5.5 Confusion Matrix for 100 Epoch.....	44
Figure 5.6 Loss and Accuracy Plot for Sign Language MNIST Model .....	45
Figure 5.7 Loss and Accuracy Plot for Author Dataset Model.....	45
Figure 5.8 Enlarge Loss and Accuracy Plot for Sign Language MNIST .....	46
Figure 5.9 Detection Test with Interference .....	52

## LIST OF TABLES

	Page
Table 2.1 List of Label and Alphabet Representation for Sign Language MNIST .....	26
Table 2.2 List of Dataset Alphabets Frequency for Author Made Datasets .....	27
Table 3.1 List of Software used during Research .....	29
Table 5.1 Model Evaluation for Sign Language MNIST Model .....	43
Table 5.2 Model Evaluation for Author Dataset Model .....	46
Table 5.3 Images of Data inside the Dataset.....	49
Table 5.4 Images of New Data inside the Dataset .....	50
Table 5.5 Detection Test for 10 Epochs .....	51
Table 5.6 D and E Alphabet Detection Test for 10 Epochs .....	52
Table 5.7 Detection Test for 30 Epochs .....	53
Table 5.8 Detection Test for 50 Epochs.....	54
Table 5.9 Detection Test for 50 Epochs.....	55
Table 5.10 Detection Test for 100 Epoch .....	55
Table 5.11 Detection Test for 50 Epoch .....	56
Table 5.12 Detection Test for 100 Epoch .....	56
Table 5.13 Interference Test for 10 Epoch .....	57
Table 5.14 Interference Test for 30 Epoch .....	58
Table 5.15 Interference Test for 50 Epoch .....	58
Table 5.16 Interference Test for 50 Epoch .....	59
Table 5.17 Interference Test for 100 Epoch .....	59
Table 5.18 Interference Test for 50 Epoch .....	60
Table 5.19 Interference Test for 100 Epoch .....	60



## LIST OF APPENDIXES

	Page
Appendix A	
Code to Import Library .....	A-1
Code to Import Data .....	A-2
Code to Check the Frequency of Each Label inside Dataset.....	A-3
Code to Separate Label and Pixel Value in Train Dataset.....	A-4
Code to Split Dataset and Reshape Image .....	A-5
Code to run model in TensorFlow .....	A-6
Code to Evaluate Model .....	A-7
Code to Implement OpenCV .....	A-8
Code to View Random Image Function .....	A-9
Code to Read Image Function .....	A-10
Code to Initialize Directory and List the Training Class.....	A-11
Code to Initialize Image Data Generator .....	A-12
Code to Initialize CNN Architecture .....	A-13
Code to Initialize Model Compile and Fit .....	A-14
Code to Retrieve Model Prediction .....	A-15
Code to Run OpenCV .....	A-16
Appendix B	
Guidance Sheet .....	B-1
Turnitin Check Sheet .....	B-2
Similarity Report Chapter 1 .....	B-3
Similarity Report Chapter 2.....	B-4
Similarity Report Chapter 3.....	B-5
Similarity Report Chapter 4.....	B-6
Similarity Report Chapter 5.....	B-7
Similarity Report Chapter 6.....	B-8
Similarity Report All Chapter.....	B-9
Appendix C	
Scientific Paper .....	C-1