

TABLE OF CONTENTS

THESIS.....	.ii
SUPERVISOR APPROVAL PAGE	.iii
EXAMINERS APPROVAL PAGE.....	.iv
STATEMENT OF THESIS ORIGINALITY	.v
PLAGIARISM-FREE STATEMENT.....	.vi
ABSTRACT	.vii
PREFACE.....	.viii
TABLE OF CONTENTS	ix
TABLE OF FIGURES	x
TABLE OF TABLES.....	xi
TABLE OF EQUATIONS	xii
TABLE OF PROGRAM MODULES.....	xiii
CHAPTER I INTRODUCTION.....	1
1.1 Background.....	1
1.2. Problem Formulation.....	2
1.3. Scope of the Problem.....	2
1.4. Research Objectives	2
1.5. Research Benefits	2
1.6. Research Methodology and System Development Method.....	3
1.7. Report Structure.....	4
CHAPTER II LITERATURE REVIEW	5
1.1 Retail Business.....	5
1.2 Warung.....	5
1.3 Kusuma Cell.....	6
1.4 Point-of-Sale.....	8
1.5 Object Detection	9
1.6 Digital Image.....	10
1.7 Image Processing.....	13
1.8 Convolutional Neural Network (CNN).....	14
1.9 Deep Learning	19
1.10 YOLOv8.....	21
1.11 Evaluation Metrics	29
1.12 Literature Review.....	31
CHAPTER III RESEARCH METHODOLOGY AND SYSTEM DEVELOPMENT.....	35
2.1 Research Method.....	35
2.2 Data Acquisition	35
2.3 Data Processing.....	37
2.4 Modelling.....	39
2.5 Evaluation	46
2.6 System Development Methodology.....	47
CHAPTER IV RESULTS AND DISCUSSION	53
3.1 Implementation.....	53
3.2 Results	67
3.3 Discussions	81
CHAPTER V CONCLUSION AND FUTURE WORK.....	84
4.1 Conclusion.....	84
4.2 Future Work	85
REFERENCES.....	86
ADDENDUM	86

TABLE OF FIGURES

Figure 2.1 An Indonesian Warung.....	6
Figure 2.2 Kusuma Cell.....	6
Figure 2.3 Kusuma Cell Table.....	7
Figure 2.4 Object Detection Example	9
Figure 2.5 RGB Color Model	11
Figure 2.6 Image Processing Example	13
Figure 2.7 CNN Architecture	14
Figure 2.8 Convolution Process.....	16
Figure 2.9 SiLU Function.....	17
Figure 2.10 Pooling Layer	18
Figure 2.11 Fully Connected Layer	18
Figure 2.12 Deep Neural Network.....	19
Figure 2.13 YOLO Grid Mechanism.....	21
Figure 2.14 YOLOv8 Performance	22
Figure 2.15 R-CNN 2-Stage Approach	24
Figure 2.16 YOLO Approach	25
Figure 2.17 YOLO Computation Example.....	26
Figure 2.18 YOLOv8 Architecture.....	28
Figure 2.19 Intersection over Union Formula	29
Figure 2.20 Intersection over Union Scoring Example	30
Figure 3.1 Research Workflow.....	35
Figure 3.2 Data Processing Pipeline	37
Figure 3.3 Annotated Image Example	37
Figure 3.4 Annotation Label Example.....	38
Figure 3.5 Model Implementation Flowchart.....	39
Figure 3.6 YOLOv8m Architecture.....	41
Figure 3.7 Sampled Region of Input Image and its Pixel Value with Padding.....	41
Figure 3.8 Illustration of Convolution Process Using a Stride of 2	42
Figure 3.9 System Architecture	49
Figure 3.10 User Interface Design.....	50
Figure 3.11 WiZ Connected App Screenshot	52
Figure 3.12 Black Dress and Red Prayer Rug	52
Figure 4.1 Raw Dataset Images Example.....	53
Figure 4.2 Annotation Result Example	54
Figure 4.3 Annotated Images Comparison	54
Figure 4.4 Object Classes Details.....	55
Figure 4.5 Dataset Analysis.....	55
Figure 4.6 Data Splitting Configuration	57
Figure 4.7 Augmented Image Comparison.....	60
Figure 4.8 Initial Screen	66
Figure 4.9 Screen After File Submission.....	66
Figure 4.10 Screen After Model Inference	67
Figure 4.11 Training Graph Results	68
Figure 4.12 Training Validation Results	70
Figure 4.13 Training Confusion Matrix Result	71
Figure 4.14 Testing Validation Result.....	73
Figure 4.15 Testing Confusion Matrix Result	74

TABLE OF TABLES

Table 2.1 Household Products Available at Kusuma Cell	7
Table 2.2 YOLO and CNN Comparison	23
Table 2.3 State of The Art	32
Table 2.4 State of The Art (Continued)	33
Table 2.5 State of The Art (Continued)	34
Table 3.1 Sample Dataset	36
Table 3.2 Kernel	42
Table 3.3 Convolution Process Calculation.....	42
Table 3.4 Convolution Result	42
Table 3.5 Mini-Batch Mean Result	43
Table 3.6 Mini-Batch Variance Result	44
Table 3.7 Normalize Result	44
Table 3.8 SiLU Result	45
Table 3.9 Hyperparameters Example	46
Table 3.10 Confusion Matrix.....	47
Table 3.11 Hardware Specifications	48
Table 3.12 Software Specifications	49
Table 3.13 Black Box Testing Framework.....	50
Table 3.14 Model Training Results per Epoch Framework	51
Table 3.15 Manual Testing Framework.....	51
Table 4.1 Class Data Distribution.....	56
Table 4.2 Augmented Images Example	59
Table 4.3 Model Training Results per Epoch.....	68
Table 4.4 Black Box Testing Results	72
Table 4.5 Overlap Test Results.....	75
Table 4.6 Overlap Test Results (Continued)	76
Table 4.7 Lighting Test Results.....	77
Table 4.8 Lighting Test Results (Continued)	78
Table 4.9 Lighting Test Results (Continued)	79
Table 4.10 Background Test Results	80

TABLE OF EQUATIONS

Equation 2.1 Mini-batch Mean.....	16
Equation 2.2 Mini-batch Variance	16
Equation 2.3 Normalize.....	16
Equation 2.4 Scale and Shift	16
Equation 2.5 SiLU	17
Equation 2.6 First Moment Estimate.....	17
Equation 2.7 Second Moment Estimate	17
Equation 2.8 Confidence	21
Equation 2.9 Precision.....	30
Equation 2.10 Recall	30
Equation 2.11 Average Precision	30
Equation 2.12 Mean Average Precision	30
Equation 3.1 Mini-batch Mean Channel 1	43
Equation 3.2 Mini-batch Mean Channel 2	43
Equation 3.3 Mini-batch Variance Channel 1	44
Equation 3.4 Mini-batch Variance Channel 2	44
Equation 3.5 Normalize Channel 1	44
Equation 3.6 Normalize Channel 2	44
Equation 3.7 SiLU Channel 1.....	45
Equation 3.8 Maxpooling	45

TABLE OF PROGRAM MODULES

Program Module 2.1 MobileNetV2 Algorithm Example	10
Program Module 2.2 RGB Classification Algorithm Example	11
Program Module 2.3 RGB Classification Algorithm Example (Continued)....	12
Program Module 2.4 Prewitt Operator Algorithm Example.....	14
Program Module 2.5 CNN Algorithm Example	15
Program Module 2.6 Deep Learning Algorithm Example	20
Program Module 2.7 YOLO Algorithm Example	27
Program Module 3.1 Import Library Command.....	40
Program Module 3.2 Train Command.....	40
Program Module 4.1 Import Library	60
Program Module 4.2 Import YOLO	61
Program Module 4.3 Set Up Dataset	61
Program Module 4.4 Train Model	62
Program Module 4.5 Conv Layer Details	62
Program Module 4.6 C2f Layer Details.....	63
Program Module 4.7 SPPF Layer Details.....	64
Program Module 4.8 Upsample Layer Details	64
Program Module 4.9 Streamlit App Pseudocode Snippet.....	65
Program Module 4.10 Validate Custom Model	69