UNIVERSITI TEKNOLOGI MARA

ENHANCED RECYCLABLE WASTE DETECTION AND CLASSIFICATION USING ARTIFICIAL INTELLIGENCE

MUHAMMAD ANAS BIN SALEHUDIN

BACHELOR OF COMPUTER SCIENCE (HONS.)
FACULTY OF COMPUTER AND
MATHEMATICAL SCIENCES

JULY 2026

SUPERVISOR APPROVAL

ENHANCED RECYCLABLE WASTE DETECTION AND CLASSIFICATION USING ARTIFICIAL INTELLIGENCE

By

MUHAMMAD ANAS BIN SALEHUDIN

2024634216

This thesis was prepared under the supervision of the project supervisor, Dr Liew Lee Hung. It was submitted to the Faculty of Computer and Mathematical Sciences and was accepted in partial fulfilment of the requirements for the degree of Bachelor of Computer Science.

Approved by

…….

Dr Liew Lee Hung

Project Supervisor

JULY 9, 2026

ACKNOWLEDGEMENT

Bismillahhirrahmanirrahim and Alhamdulillah, praise and thanks to God because with His abundant grace, I was able to complete this study within the given period. I would like to extend my sincere gratitude to everyone who contributed to the successful completion of this project, whether directly or indirectly. There were many challenges encountered along the way, and I deeply appreciate everyone's encouragement and support throughout this journey.

First and foremost, I would like to express my heartfelt thanks to my supervisor, Dr. Liew Lee Hung, for her invaluable guidance, patience, and constructive feedback throughout the entire course of this project. Her/his expertise and continuous support played a vital role in shaping the direction of this research and in helping me overcome the technical and academic challenges I faced along the way. I would also like to extend my appreciation to Dr. Liew Chin Ying, my CSP650 lecturer, for her dedication, timely delivery of course material, and valuable suggestions for improvement, which have greatly contributed to raising the quality of this report. My sincere thanks also go to my classmates, who generously gave their time to test the EcoSort AI system and complete the Alpha Testing questionnaire; their honest feedback was instrumental in evaluating and refining the system. I am also deeply grateful to my family and friends, who have supported and understood me throughout this research process. I have drawn strength from your support, and I consider myself truly fortunate to have you in my life.

In conclusion, I am grateful for the opportunity and confidence given to me to carry out this research. I am proud of how this study has developed my skills and understanding as a computer science student. Without the assistance of everyone mentioned above, this achievement would not have been possible, and I sincerely appreciate everyone who has been part of this meaningful academic journey.

ABSTRACT

Mismanagement of solid and recyclable waste is a serious problem of the 21st century. Although manual classification is necessary for waste protection and human health, it is often inefficient in terms of cost, time, and accuracy, especially in the real environment of industry, where waste inputs are not as clean as in training sets. Designed as a hybrid solution, EcoSort AI employs a two-stage approach: YOLOv8 for object detection, and ResNet18 for classification of five material categories of recyclables, with both static image and live camera detection modes supported. The dataset collection process was conducted in 6 stages of increasing complexity to build the detection model, preprocess the images to improve contrast and remove noise before inference, and create a web-based application to facilitate the upload of images, live camera recording, and reporting of detection results. The detection model achieved a mean average precision of 91.1 percent and the classification model achieved a validation accuracy of 93.0 percent. All test cases were passed in functional testing and usability testing of seven respondents gave average score of 4.17 out of 5.00, which shows a positive attitude towards the system. A correction mechanism was developed and validated at the functional level where corrections were recorded for future retraining but was not yet thoroughly evaluated with respect to the accuracy of the model, using data not included in the validation. The study concludes that the proposed hybrid architecture meets the identified research problem of automated and field-friendly waste detection and classification and recommends further expanding training data under various handheld camera conditions, further testing on held-out data to validate retraining and testing lightweight classifier architectures for real-time detection.

TABLE OF CONTENTS

CONTENTS	PAGE
SUPERVISOR APPROVAL	II
STUDENT DECLARATION	III
ACKNOWLEDGEMENT	IV
ABSTRACT	V
TABLE OF CONTENTS	VI
LIST OF FIGURES	XI
LIST OF TABLES	XIII
LIST OF ABBREVIATION	xv
CHAPTER 1: INTROUDUCTION	
1.1 PROJECT BACKGROUND	1
1.2 PROBLEM STATEMENT	3
1.3 PROJECT AIM AND OBJECTIVE	5
1.4 PROJECT SCOPE	5
1.4.1 Target Users	5
1.4.2 System Function	6
1.4.3 Application Platform	6
1.5 SIGNIFICANCE OF THE STUDY	7
1.5.1 Importance	7
1.5.2 Usefulness	7
1.5.3 Benefits	8
1.6 CONCLUSION	8
CHAPTER 2 : LITERATURE REVIEW	
2.1 INTRODUCTION	10
2.2 WASTE DETECTION AND CLASSIFICATION	10