



TABLE OF CONTENTS

| | |
|----------------------------------------------|------------|
| APPROVAL PAGE | ii |
| STATEMENT OF PLAGIARISM-FREE | iv |
| FOREWORD..... | v |
| TABLE OF CONTENTS..... | vii |
| LIST OF FIGURES | ix |
| LIST OF TABLES | x |
| ABSTRACT | 1 |
| INTISARI | 2 |
| CHAPTER 1: INTRODUCTION..... | 3 |
| 1.1 Background | 3 |
| 1.2 Problem Statement..... | 6 |
| 1.3 Scope of Problem..... | 6 |
| 1.4 Research Objective | 7 |
| 1.5 Research Benefits | 7 |
| CHAPTER 2: LITERATURE REVIEW..... | 8 |
| CHAPTER 3: THEORETICAL BASIS | 17 |
| 3.1 Deep Learning | 17 |
| 3.2 Autonomous Driving..... | 17 |
| 3.3 Imitation Learning..... | 17 |
| 3.4 Behavior Cloning | 18 |
| 3.5 Convolutional Neural Network..... | 19 |
| 3.6 Carla Simulator..... | 21 |
| 3.7 Mean Absolute Error..... | 21 |
| 3.8 Matrix Evaluation..... | 22 |
| CHAPTER 4: RESEARCH METHODS | 24 |
| 4.1 System Analysis | 24 |
| 4.2 Tools and Materials..... | 24 |
| 4.3 Work Procedures..... | 25 |
| 4.4 System Architecture Design | 26 |
| 4.5 Data Collection | 28 |
| 4.6 Model Training..... | 28 |



| | |
|---------------------------------------------------|-----------|
| CHAPTER 5: IMPLEMENTATION | 31 |
| 5.1 Environment Preparation | 31 |
| 5.2 Dataset Collection | 31 |
| 5.3 Implementation of CNN | 33 |
| 5.4 Training Model | 34 |
| CHAPTER 6: RESULTS AND DISCUSSIONS | 37 |
| 6.1 Dataset Analysis | 37 |
| 6.2 Training Model Results | 39 |
| 6.3 Model Validation Results | 49 |
| CHAPTER 7: CONCLUSION AND SUGGESTION | 59 |
| BIBLIOGRAPHY | 61 |



LIST OF FIGURES

| | |
|-----------------------------------------------------------------------------|----|
| Figure 3. 1 CNN Architecture | 19 |
| Figure 4. 1 System Architecture | 26 |
| Figure 5. 1 Autopilot Function..... | 33 |
| Figure 5. 2 Documentation of Dataset Collection..... | 33 |
| Figure 5. 3 Parameter Training Configuration..... | 34 |
| Figure 5. 4 CNN Model | 34 |
| Figure 5. 5 Main Training Function..... | 35 |
| Figure 6. 1 Dataset Collection Using Semantic Segmentation Camera..... | 37 |
| Figure 6. 2 The dataset collection in the simulation environment..... | 38 |
| Figure 6. 3 Point Loss (Training Loss) | 41 |
| Figure 6. 4 Training Model Process | 41 |
| Figure 6. 5 Examples of Training Images..... | 42 |
| Figure 6. 6 Straight Line Waypoint Prediction Training Image | 43 |
| Figure 6. 7 Turn Waypoint Prediction Training Image..... | 45 |
| Figure 6. 8 Maintaining Safe Distance Waypoint Prediction Training | 47 |
| Figure 6. 9 Validation Loss..... | 49 |
| Figure 6. 10 Examples of Validation Images..... | 50 |
| Figure 6. 11 Straight Line Waypoint Prediction Validation Image | 52 |
| Figure 6. 12 Turn Waypoint Prediction Validation Image | 54 |
| Figure 6. 13 Maintaining Safe Distance Waypoint Prediction Validation | 56 |



LIST OF TABLES

| | |
|-------------------------------------------|----|
| Table 2. 1 Literature Review..... | 13 |
| Table 4. 1 Component List | 25 |
| Table 4. 2 Research Actions..... | 25 |
| Table 6. 1 Training Model Parameters..... | 39 |