UNIVERSITAS
GADJAH MADA
SIMULATION OF AN ADAPTIVE TRAFFIC LIGHT SYSTEM USING INDUCTION LOOP SENSOR
BAIHAQI HAKIM, Dr. Raden Sumiharto, S.Si., M.Kom
Universitas Gadjah Mada, 2024 | Diunduh dari http://etd.repository.ugm.ac.id/

TABLE OF CONTENTS

AGREEMENT PAGE ii
FOREWORD iii
TABLE OF CONTENTS vi
LIST OF FIGURES viii
LIST OF TABLES ix
ABSTRACT x
INTISARI xi
CHAPTER I 1
1.1 Background 1
1.2 Problem Formulation 3
1.3 Problem Limitation 3
1.4 Research Objectives 4
1.5 Benefits of Research 4
1.6 Research Methodology 4
CHAPTER II LITERATURE REVIEW 6
CHAPTER III THEORY FOUNDATION 10
3.1 Traffic Engineering Concept 10
3.2 Adaptive Traffic Light System Architecture 15
3.3 Multi-Induction Loop Sensors 18
3.4 Traffic Light Signal Control 20
3.5 Simulation of Urban Mobility (SUMO) 21
3.6 Traffic Density Measurement 22
3.7 System Performance Index 23
CHAPTER IV RESEARCH METHOD 24
4.1 Research Stages 24
4.2 Tools and Materials 24
4.3 Problem Analysis 25
4.4 Data Acquisition 26
4.5 System Model Planning 26
4.6 System Test Design 27
4.7 Traffic Light Design 28
4.8 Induction Loop Detector Design 29
4.9 Road Intersection Layout Design 30
CHAPTER V IMPLEMENTATION 31
5.1 Environment 31
5.2 Traffic Demand 33
5.3 Vehicle Route 34
5.4 Traffic Light Cycle 38
5.5 Induction Loop Sensor Implementation 39
5.6 System Testing 41
5.7 Actuated Traffic Light 42
CHAPTER VI RESULTS AND DISCUSSION 44
6.1 Test Results 44
6.2 Static Traffic Light Low Demand Simulation 45
6.3 Actuated Traffic Light Low Demand Simulation 48
6.4 Static Traffic Light Medium Demand Simulation 50
6.5 Actuated Traffic Light Medium Demand Simulation 53

UNIVERSITAS
GADJAH MADA
SIMULATION OF AN ADAPTIVE TRAFFIC LIGHT SYSTEM USING INDUCTION LOOP SENSOR
BAIHAQI HAKIM, Dr. Raden Sumiharto, S.Si., M.Kom
Universitas Gadjah Mada, 2024 | Diunduh dari http://etd.repository.ugm.ac.id/

6.6 Static Traffic Light High Demand Simulation 55
6.7 Actuated Traffic Light High Demand Simulation 59
6.8 Results Discussion 62
CHAPTER VII CONCLUSION AND SUGGESTION 68
7.1 Conclusion 68
7.2 Suggestion 69
REFERENCES 70
APPENDIX 72

UNIVERSITAS
GADJAH MADA
SIMULATION OF AN ADAPTIVE TRAFFIC LIGHT SYSTEM USING INDUCTION LOOP SENSOR
BAIHAQI HAKIM, Dr. Raden Sumiharto, S.Si., M.Kom
Universitas Gadjah Mada, 2024 | Diunduh dari http://etd.repository.ugm.ac.id/

LIST OF FIGURES

Figure 3.1 Urban Road Traffic Flow (Slinn et al., 2005) 11
Figure 3.2 Automatic Traffic Counter (Slinn et al., 2005) 12
Figure 3.3 Road Traffic Signs (Slinn et al., 2005) 14
Figure 3.4 Protocol Architecture (Zanella et al., 2014) 15
Figure 3.5 City System Architecture 17
Figure 3.6 Multiple-inductive loop sensor (a) Loops in series, (b) Multiple-loop on a road and (c) Loop design (Ali et al., 2013). 18
Figure 3.7 Multi-inductive loop electrical circuit (Ali et al., 2013). 19
Figure 3.8 Signal output for different vehicles (Ali et al., 2013). 20
Figure 4.1 Process of Research 24
Figure 4.2 Vehicle Travel Time Example (Song & Min, 2018). 26
Figure 4.3 Vehicle Speed with Kalman Filter Example (Dian Khumara et al., 2018). 27
Figure 4.4 System Design Process. 27
Figure 4.5 System Design Layout 28
Figure 4.6 Traffic Light Design 29
Figure 4.7 Induction Loop Detector Design 29
Figure 4.8 Ring Road Kaliurang Street Intersection Design 30
Figure 5.1 Ring Road Kaliurang Street Intersection 31
Figure 5.2 OSMWebWizard Script Overview 32
Figure 5.3 Map Area Selected for Simulation 32
Figure 5.4 OSMWebWizard Vehicle Generation Options 33
Figure 5.5 Traffic Demand for Low (left), Medium (middle), and High Density (right). 34
Figure 5.6 OSM Vehicle Route Files 35
Figure 5.7 Python Code to Generate Random Trips 35
Figure 5.8 Main Function for Random Trip Generator 36
Figure 5.9 Main Function for Random Trip Generator (Continued) 37
Figure 5.10 Passenger Car Trips File 37
Figure 5.11 Static Traffic Light Cycle 38
Figure 5.12 Actuated Traffic Light Cycle 39
Figure 5.13 Traffic Light Phase Program 39
Figure 5.14 Implementation of Induction Loop Detector E1 for Junction 40
Figure 5.15 Assigning E1 Detectors 40
Figure 5.16 Traffic Light E1 Induction Loop Detectors Labeled 41
Figure 5.17 Running SUMO Simulation 42
Figure 6.1 Static Traffic Light Low Demand Occupancy Graph 47
Figure 6.2 Actuated Traffic Light Low Demand Occupancy Graph 49
Figure 6.3 Static Traffic Light Medium Demand Occupancy Graph 52
Figure 6.4 Actuated Traffic Light Medium Demand Occupancy Graph 54
Figure 6.5 Static Traffic Light High Demand Occupancy Graph 57
Figure 6.6 Simplified Static Traffic Light High Demand Occupancy Graph 58
Figure 6.7 Actuated Traffic Light High Demand Occupancy Graph 60
Figure 6.8 Simplified Actuated Traffic Light High Demand Occupancy Graph 62
Figure 6.9 Comparison of Static and Actuated Traffic Light at Low Demand 63
Figure 6.10 Comparison of Static and Actuated Traffic Light at Medium Demand 64
Figure 6.11 Comparison of Static and Actuated Traffic Light at High Demand 65

UNIVERSITAS
GADJAH MADA
SIMULATION OF AN ADAPTIVE TRAFFIC LIGHT SYSTEM USING INDUCTION LOOP SENSOR
BAIHAQI HAKIM, Dr. Raden Sumiharto, S.Si., M.Kom
Universitas Gadjah Mada, 2024 | Diunduh dari http://etd.repository.ugm.ac.id/

LIST OF TABLES

Table 2.1 Summary of previous studies 8
Table 2.2 Summary of previous studies (continued) 9
Table 3.1 Change in road traffic in the UK (Slinn et al., 2005). 10
Table 3.2 Performance Analysis (Tchuitcheu et al., 2020) 23
Table 4.1 Research Equipment 25
Table 4.2 Laptop Specification 25
Table 4.3 Data Acquired 25
Table 4.4 Design of Results Analysis 28
Table 6.1 Induction Loop Detector E1 Data Types 44
Table 6.2 Static Traffic Light Low Demand Vehicle Count 45
Table 6.3 Static Traffic Light Low Demand Detectors Occupancy Average 46
Table 6.4 Actuated Traffic Light Low Demand Detectors Occupancy Average 48
Table 6.5 Static Traffic Light Low Demand Vehicle Count 50
Table 6.6 Static Traffic Light Medium Demand Detectors Occupancy Average 50
Table 6.7 Static Traffic Light Medium Demand Detectors Occupancy Average (continued) 51
Table 6.8 Actuated Traffic Light Medium Demand Detectors Occupancy Average 53
Table 6.9 Static Traffic Light High Demand Vehicle Count 56
Table 6.10 Static Traffic Light High Demand Detectors Occupancy Average 56
Table 6.11 Actuated Traffic Light High Demand Detectors Occupancy Average 59
Table 6.10.1 Static Traffic Light High Demand Detectors Occupancy Average 72
Table 6.10.2 Static Traffic Light High Demand Detectors Occupancy Average (continued) 73
Table 6.11.1 Actuated Traffic Light High Demand Detectors Occupancy 74
Table 6.11.2 Actuated Traffic Light High Demand Detectors Occupancy (continued) 75