

DESIGN AND DEVELOP VEHICLE ANTI-COLLISION WARNING SYSTEM

By

Himawan Kunto D.A.
22152004

MASTER'S DEGREE
in

MECHANICAL ENGINEERING – MECHATRONIC
FACULTY OF ENGINEERING AND INFORMATION TECHNOLOGY



SWISS GERMAN UNIVERSITY
The Prominence Tower
Jalan Jalur Sutera Barat No. 15, Alam Sutera
Tangerang, Banten 15143 - Indonesia

July 2022

Revision after Thesis Defense on 5 July 2022

STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.

Himawan Kunto D.A.

Student

Date

Approved by:

Dr. Henry Nasution

Thesis Advisor

Date

Dena Hendriana, B.Sc., S.M., Sc.D.

Thesis Co-Advisor

Date

Dr. Maulahikmah Galinium, S.Kom., M.Sc.

Dean

Date

Himawan Kunto D.A.

ABSTRACT

DESIGN AND DEVELOP VEHICLE ANTI COLLISION WARNING SYSTEM

By

Himawan Kunto D.A.
Dr. Henry Nasution, Advisor
Dena Hendriana, BSc., S.M., Sc.D., Co-Advisor

SWISS GERMAN UNIVERSITY

The automobile industry grows exponentially due to the vehicle demand but in another side the road accident is still quite high and most of the accident due to vehicle are collide head-to-head or rear-end crush. Many technologies already exist in the area of vehicle anti-collision still and also many researches are going in the vehicular anti-collision field. The proposed system is consisted of two independent warning modules namely laser range finder and ultrasonic. This module is fixed in all vehicles to reduce the vehicle collision. When the object is detected a few meters, Arduino activate the electrical driver to trigger actuator namely buzzer and lamp to working follow the setup programing.

Keywords: Vehicle anti-collision, Collision Warning System, Laser Range Finder Sensor, Ultrasonic Sensor.

© Copyright 2022
by Himawan Kunto D.A.
All rights reserved

DEDICATION

I dedicate this works for my belove country: Indonesia

ACKNOWLEDGEMENTS

In this opportunity, the researcher would like to express great gratitude to:

1. Mr. Dr. Henry Nasution and Mr. Dena Hendriana, B.Sc., S.M., Sc.D, as advisor and Co-Advisor who has provided support, both time, energy and thoughts during the mentoring period.
2. All teaching staff of the Swiss German University master of mechatronic program for all the knowledge, direction, assistance and guidance during the 2021-2022 lecture period. Do not forget all the staff of the Secretariat of the Postgraduate Program in Administrative Sciences, University of Indonesia for their help and cooperation so far.
3. Parents and the whole extended family for their support, attention and prayers during the researcher's lectures and thesis writing.
4. All classmates in the Master of Mechanical Engineering program batch-13 at Swiss German University.

In preparing this thesis, the researcher has limitations, so this thesis is open to receiving suggestions and input. In addition, the researcher apologizes if the researcher has made mistakes, whether intentional or not, during the preparation period. Finally, I hope this thesis will be useful for all of us.

Jakarta, July 2022

Himawan Kunto Dewoto Aji

TABLE OF CONTENTS

STATEMENT BY THE AUTHOR.....	2
ABSTRACT.....	3
DEDICATION.....	5
ACKNOWLEDGEMENTS.....	6
1. CHAPTER 1 – INTRODUCTION.....	12
1.1 Background.....	12
1.2 Research Problems.....	17
1.3 Research Objectives.....	17
1.4 Significance of Study.....	17
1.5 Research Questions.....	18
1.6 Expected Outputs.....	18
2. CHAPTER 2 - LITERATURE REVIEW.....	19
2.1 Previous Research Search Method.....	19
2.2 Research Questions on Systematic Literature Review.....	19
2.3 Research Database Search and Keyword.....	19
2.4 Search Criteria.....	19
2.5 Document Searches.....	20
2.6 Anti-Collision Warning System.....	24
2.7 Components of the System.....	26
2.8 Hardware Description.....	29
2.9 Vehicle Monitoring System.....	40
2.10 Active Laser Range finder.....	43
3. CHAPTER 3 – RESEARCH METHODS.....	52
3.1 Overview of the development method.....	52
3.2 Short Method Step Description.....	56
3.3 Fishbone Analysis.....	59
3.4 Desain and Engineering Analysis.....	60
3.5 Laser Rangefinder Front System.....	68
1. CHAPTER 4 – RESULT AND DISCUSSION.....	75
4.1 Back End (Rear) Sensor System.....	75
4.2 Front End Sensor System.....	88

4.3 Test Result in Various Condition.....	100
CHAPTER 5 – CONCLUSION AND RECOMMENDATION	117
5.1 Conclusion	117
5.2 Recommendation	117
REFERENCE.....	119
CURRICULUM VITAE.....	125

LIST OF FIGURES

Figure 1.1 Road Accident Summary	13
Figure 1.2 Indonesia Accident Report Year-to-year	14
Figure 1.3 Indonesia Accident Report Year-to-year	15
Figure 1.4 Block diagram for vehicle anti-collision system	16
Figure 1.5 Implemented Prototype Device	17
Figure 2.1 Previous & Current Related Research Comparison	21
Figure 2.2 ADAS Applications	24
Figure 2.3 Operation of a Sharp Distance Sensor	27
Figure 2.4. Voltage-distance characteristics graph of Sharp Distance Sensor	28
Figure 2.5. Illustration of Calculation the distance on the Ultrasonic sensor	30
Figure 2.6. Ultrasonic sensor distance measurement	33
Figure 2.7. Reflected waves from various inclined surface target	34
Figure 2.8. Ultrasonic Sensor Type	35
Figure 2.9. Schematic showing general representation of FECAS	36
Figure 2.10. Schematic showing arrangement of sensors and actuators	37
Figure 2.11. Ultrasonic sensors and Arduino circuit diagram. Sensors' echo and trigger pin are connected to Arduino's digital pins	40
Figure 2.12. System arrangement of data acquisition process	41
Figure 2.13. Data measurement process is done by activating both sensors alternately and the process repeated in a loop	42
Figure 2.14. Block Diagram of Prototype	43
Figure 2.15. General experimental laWet of the designed active range finder	44
Figure 2.16. Simplified experimental laWet of the active range finder	45
Figure 2.17. Measured distance versus the distance between the optic axis and spot	46
Figure 2.18. Configuration of the designed prototype of laser range finder using a CMOS image sensor when applied in the automotive field	49
Figure 2.19. Experimental tests of the designed active range finder conducted on a highway at range of 5–45 m.	50
Figure 3.1 Prototype Testing Multiplier Method Flow Chart	52
Figure 3.2 Prototype Testing Multiplier Method Flow Chart	56
Figure 3.3 Fish Bone Diagram	59
Figure 3.4 Working System of Prototype	61
Figure 3.5 Ultrasonic Rear Warning System	65
Figure 3.6 Ultrasonic Rear Warning System Fritzing	66
Figure 3.7 Ultrasonic Working Principal	66
Figure 3.8 Ultrasonic Rear Warning System Location	68
Figure 3.9 Laser Range Finder Front Warning System	68
Figure 3.10 Laser Range Finder	69
Figure 3.11 Laser Range Finder Group	70
Figure 3.12 Laser Range Finder Fritzing	71
Figure 3.13 Laser Range Finder Front Warning System	72
Figure 3.14 Laser Range Finder Front Warning System Calibration	73
Figure 3.15 Pulsed laser ranging principle diagram	74
Figure 3.16 Waveforms	74
Figure 4.1 Cicuit for Arrangement of Resistors, LEDs, Buzzer	76

Figure 4.2 Powered Circuit for Motion Detector with LEDs	76
Figure 4.3 Rear Ultrasonic Warning System Prototype.....	77
Figure 4.4 Position of All Sensors	78
Figure 4.5. Installation and Location of Ultrasonic Warning Syastem.....	82
Figure 4.6. Ultrasonic Warning System Concept	84
Figure 4.7 Scenario 1 Cubic with 10cm side one sensor	85
Figure 4.8 Scenario 1 Cubic with 20cm side one sensor	85
Figure 4.9 Scenario 1 Cubic with 20cm side one sensor	86
Figure 4.10 Scenario 2 Cubic with 10cm side two sensor	86
Figure 4.11 . Scenario 2 Cubic with 20cm side two sensor	87
Figure 4.12 Scenario 2 Cubic with 40cm side two sensor	87
Figure 4.13. Location of Laser Range Finder Warning Syastem	89
Figure 4.14. Installation of Laser Range Finder Warning Syastem.....	89
Figure 4.15 Laser Range Finder Red Point.....	91
Figure 4.16. Laser Range Finder System Location Setup	91
Figure 4.17. Laser Range Finder System Location Testing for Static Object	92
Figure 4.18. Laser Range Finder System Location Testing for Dynamic Object.....	95
Figure 4.19. Light Warning Connected to Laser Range Finder.....	96
Figure 4.20. Light Warning Activation when Velocity Exceed the Limit.....	97
Figure 4.21. Laser Range Finder System Night Testing.....	100
Figure 4.22. Laser Range Finder Dot During Night Testing	102
Figure 4.23. Taillight image of a vehicle at different distance.	103
Figure 4.24 Rear-setup ultrasonic sensor diagram.....	105
Figure 4.25 Ultrasonic sensor array diagram	106
Figure 4.26 Returns of three sensors.....	107
Figure 4.27 Figure Percentages of all following vehicles with TTC	114
Figure 4.28 Moving vehicles spacing diagram	115
Figure 4.29 Simulation results of three conditions	116

LIST OF TABLES

Table 2-1. Statistical results of performance experiments for active range finder within range of 1–8 m.....	47
Table 4-1 Calibration Ultrasonic Warning System.....	88
Table 4-2. Range of Safe Distance.....	99
Table 4-3. Distance Values, Measured Versus Displayed in the Sensor	101
Table 4-4. Initial Calibration of Laser Range Finder.....	102
Table 4-5 Results for visual acuity measurement—system vs human observers	109
Table 4-6 Typical images captured during dust experiments	110
Table 4-7 Table Result in Dust and Rainy Condition.....	111
Table 4-8 Sensor Test Performance of Detection	112