
Surat Tugas / Letter of Appointment

Nomor/
Number ST/THS2/0225/AAO/II/2022 – DiPTanggal/
Date 25 Februari 2022 / 25 February 2022

Penugasan Sebagai Pembimbing Utama/Pendamping Skripsi Mahasiswa S2 Semester Genap 2021/2022
Appointment of Thesis Advisor/Co-Advisor for Master's Degree Student(s) in Even Semester 2021/2022

Fakultas Teknik & Teknologi Informasi / Faculty of Engineering & Information TechnologyDekan Fakultas Teknik dan Teknologi Informasi, Universitas Swiss German/
*The Dean of Engineering and Information Technology Faculty of Swiss German University,*Menimbang/ *Considering:*

1. Perkuliahan S2 semester 2 yg telah berakhir/ *The lectures for semester 2 have finished.*
2. Persyaratan untuk mencapai gelar pasca sarjana/ *Requirements for Master's Degree graduation.*

Memperhatikan/ *Referring to:* Hasil penunjukan Dekan Fakultas Teknik dan Teknologi Informasi/ *The appointment by the Dean of Engineering and Information Technology Faculty.**Memutuskan/ Has Reached the Decision:*

1. Dengan ini menugaskan kepada dosen yang tercantum pada lampiran, sebagai Pembimbing Utama/Pendamping skripsi program Strata Dua (S2) mahasiswa yang tercantum pada lampiran dengan masa penugasan 1 Maret 2022 sampai dengan 20 Juni 2022/ *Herewith gives the task to the lecturers as listed on the attachment to become Thesis Advisor/Co-Advisor for the Masters student(s) listed on the attachment with period of task starting from 1 March 2022 until 20 June 2022.*
2. Dosen yang bersangkutan harus melaksanakan tugas dan tanggung jawab sebaik-baiknya, sesuai dengan petunjuk pembimbingan skripsi dari SGU/ *The appointed lecturer shall accomplish the task in responsible ways in line with the thesis guidelines and other regulations given by SGU.*

Terima kasih atas perhatian dan kerjasama Saudara/ *Thank you for your attention and cooperation.*

Dekan/Dean,

Dr. Maulahikmah Galinium, S.Kom, M.Sc.
Dekan Fakultas Teknik dan Teknologi Informasi/
*Dean of Engineering and Information Technology Faculty*Lampiran/ *Attachment:*Daftar Nama Pembimbing Utama, Pendamping dan Mahasiswa pada Semester Genap 2021/2022
List of Thesis Advisor, Co-Advisor and Student in Even Semester 2021/2022.

1. Lampiran 1/ *Attachment 1:* Program Studi Magister Teknik Informatika/ *Study Program of Master of Information Technology*
2. Lampiran 2/ *Attachment 2:* Program Studi Magister Teknik Mesin/ *Study Program of Master of Mechanical Engineering*

Lampiran 2 Surat Keputusan: ST/THS2/0225/AAO/II/2022 – DiP
Attachment 2 to the Decree: ST/THS2/0225/AAO/II/2022 – DiP

Daftar Nama Pembimbing Utama/Pendamping Skripsi Pada Program Magister,
Program Studi Magister Teknik Mesin, Fakultas Teknik dan Teknologi Informasi, pada Semester Genap 2021/2022
(Februari - Juni 2022)

*List of The Thesis Advisor/Co-Advisor Master's Degree Program,
Study Program of Mechanical Engineering, Faculty of Engineering & Information Technology, in Even Semester
2021/2022 (February – June 2022)*

Daftar Pembimbing Utama/List of Advisor

Nr.	Nama Pembimbing Utama/ <i>The Advisor's Name</i>	Status Dosen/ <i>Lecturer's Status</i>	Nama Mahasiswa/ <i>Student's Name</i>	NIM/ <i>Student's ID</i>	Judul Skripsi/ <i>Thesis Title</i>
1	Dena Hendriana, BSc., S.M., Sc.D.	Dosen Tetap/ Homebase Lecturer	Samuel Onasis Keliat	22152003	VACUUM DISTILLATION OIL PURIFICATION SYSTEM TO EXTENT LIFE TIME OF TURBINE LUBE OIL IN STEAM POWER GENERATION PLANTS
			Syaifuddin Zuhri	22152006	LAPPING MACHINE AUTOMOTION SYSTEM FOR OVERHOUL HYDRAULIC PUMP SMALL HYDRAULIC EXCAVATOR
			Yudhistira Nizar	22152008	AUTOMATIC WARNING SYSTEM FOR PREVENT COLLISIONS AND PROVIDE SAFE DISTANCE BETWEEN HEAVY DUTY-TRUCKS
2	Dr. Hanny J. Berchmans	Dosen Tetap/ Homebase Lecturer	Hafidz Akbar	22052011	WATER LEVEL CONTROL PID TUNING BY FUZZY-BASED METHOD FOR A BOILERSTEAM DRUM
3	Dr. Ir. Gembong Baskoro, M.Sc.	Dosen Tetap/ Homebase Lecturer	Rustanto	22152009	MTBF IMPROVEMENT SCANIA R580 BY USING FMEA ANALYSIS IN FULL MAINTENANCE CONTRACT PT SIS ADARO
			Firdaus Agung Syafutra	22152010	IMPACT OF CUSTOMER EXPERIENCE CHANGE MANAGEMENT WITH ADKAR MODELS TO IMPROVE PERFORMANCE MAINTENACE SCHEDULE AND EXECUTION AT CUSTOMER PT UNITED TRACTORS SITE JEMBAYAN - INDONESIA
4	Dr. Ir. Henry Nasution, M.T.	Dosen Tetap/ Homebase Lecturer	Hery Cahyadi	22152007	DROWSINESS DETECTION WITH COMPUTER VISION FOR HEAVY EQUIPMENT HAULER
			Himawan Kunto Dewoto Aji	22152004	DESIGN AND DEVELOP VEHICLE ANTI COLLISION SYSTEM
			Nelson Purba	22152002	APPLICATION OF COMPUTER VISION TO DETECT DEFECTS ON COPPER WIRE
5	Dr. Tanika D Sofianti S.T., M.T.	Dosen Tetap/ Homebase Lecturer	Anggi Febrianto	22152005	OPTIMIZING PARTS AVAILABILITY SCANIA PRODUCT THROUGH PREVENTIVE MAINTENANCE IN LEADING INDONESIAN HEAVY EQUIPMENT COMPANIES CASE SITE SUPPORT KUTAI BARAT
			William Septianugraha M	22152011	IMPROVING MAINTENANCE QUALITY ON HYDRAULIC SYSTEMS OF GD825A-2 TO REDUCE UNSCHEDULE BREAKDOWN IN INDONESIA HEAVY EQUIPMENT LEADING DISTRIBUTOR COMPANY

Daftar Pembimbing Pendamping/List of Co-Advisor

Nr.	Nama Pembimbing Pendamping/ <i>The Co-Advisor's Name</i>	Status Dosen/ <i>Lecturer's Status</i>	Nama Mahasiswa/ <i>Student's Name</i>	NIM/ <i>Student's ID</i>	Judul Skripsi/ <i>Thesis Title</i>
1	Dena Hendriana, BSc., S.M., Sc.D.	Dosen Tetap/ Homebase Lecturer	Himawan Kunto Dewoto Aji	22152004	DESIGN AND DEVELOP VEHICLE ANTI COLLISION SYSTEM
2	Dr. Aditya Tirta Pratama, S.Si, M.T.	Dosen Tetap/ Homebase Lecturer	Rustanto	22152009	MTBF IMPROVEMENT SCANIA R580 BY USING FMEA ANALYSIS IN FULL MAINTENANCE CONTRACT PT SIS ADARO
			Firdaus Agung Syafutra	22152010	IMPACT OF CUSTOMER EXPERIENCE CHANGE MANAGEMENT WITH ADKAR MODELS TO IMPROVE PERFORMANCE MAINTENACE SCHEDULE AND EXECUTION AT CUSTOMER PT UNITED TRACTORS SITE JEMBAYAN - INDONESIA
3	Dr. Eng. Cuk Supriadi Ali Nandar	Dosen Tidak Tetap/ Part Time Lecturer	Hery Cahyadi	22152007	DROWSINESS DETECTION WITH COMPUTER VISION FOR HEAVY EQUIPMENT HAULER

Daftar Pembimbing Pendamping / List of Co-Advisor

Nr.	Nama Pembimbing Pendamping / The Co-Advisor's Name	Status Dosen / Lecturer's Status	Nama Mahasiswa / Student's Name	NIM / Student's ID	Judul Skripsi / Thesis Title
4	Dr. Hanny J. Berchmans	Dosen Tetap / Homebase Lecturer	Samuel Onasis Keliat	22152003	VACUUM DISTILLATION OIL PURIFICATION SYSTEM TO EXTENT LIFE TIME OF TURBINE LUBE OIL IN STEAM POWER GENERATION PLANTS
			Yudhistira Nizar	22152008	AUTOMATIC WARNING SYSTEM FOR PREVENT COLLISIONS AND PROVIDE SAFE DISTANCE BETWEEN HEAVY DUTY-TRUCKS
5	Dr. Ir. Gembong Baskoro, M.Sc.	Dosen Tetap / Homebase Lecturer	Anggi Febrianto	22152005	OPTIMIZING PARTS AVAILABILITY SCANIA PRODUCT THROUGH PREVENTIVE MAINTENANCE IN LEADING INDONESIAN HEAVY EQUIPMENT COMPANIES CASE SITE SUPPORT KUTAI BARAT
			Willian Septianuggraha M	22152011	IMPROVING MAINTENANCE QUALITY ON HYDRAULIC SYSTEMS OF GD825A-2 TO REDUCE UNSCHEDULE BREAKDOWN IN INDONESIA HEAVY EQUIPMENT LEADING DISTRIBUTOR COMPANY
6	Dr. Ir. Henry Nasution, M.T.	Dosen Tetap / Homebase Lecturer	Syaifuddin Zuhri	22152006	LAPPING MACHINE AUTOMOTION SYSTEM FOR OVERHOUL HYDRAULIC PUMP SMALL HYDRAULIC EXCAVATOR
			Hafidz Akbar	22052011	WATER LEVEL CONTROL PID TUNING BY FUZZY-BASED METHOD FOR A BOILERSTEAM DRUM
7	Dr. Widi Setiawan	Dosen Tetap / Homebase Lecturer	Nelson Purba	22152002	APPLICATION OF COMPUTER VISION TO DETECT DEFECTS ON COPPER WIRE

Jumlah Pembimbing Utama Skripsi Studi Program Magister Teknik Mesin pada Semester Genap 2021/2022 adalah 5 orang
The Thesis Advisor of Study Program of Master of Mechanical Engineering Even Semester 2021/2022 in total are 5 persons

Jumlah Pembimbing Pendamping Skripsi Studi Program Magister Teknik Mesin pada Semester Genap 2021/2022 adalah 7 orang
The Thesis Co-Advisor of Study Program of Master of Mechanical Engineering Even Semester 2021/2022 in total are 7 persons

Dekan/Dean,


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

Dekan Fakultas Teknik dan Teknologi Informasi/

Dean of Engineering and Information Technology Faculty

STATEMENT BY THE AUTHOR

Name of Student : Syaifuddin Zuhri
Student ID : 22152006
Faculty : Engineering & Information Technology
Study Program : Mechanical Engineering – Mechatronics Concentration
Date of Defense : 05 July 2022
Thesis Title : Lapping Machine with Arduino for Overhaul Hydraulic Pump At Small Hydraulic Excavator Komatsu

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.



Syaifuddin Zuhri
(Name of Student)

Approved by:
Date: 18 July 2022



Dena Hendriana, B.Sc, S.M., Sc.D
(Thesis Advisor)



Dr. Ir. Henry Nasution, M.T
(Thesis Co-Advisor)

Acknowledged by:
Date: 18 July 2022



Dr. Maulahikmah Galinium, S.Kom, M.Sc.
(Dean of Faculty of Engineering & Information Technology)

**LAPPING MACHINE WITH ARDUINO FOR OVERHOUL
HYDRAULIC PUMP AT SMALL HYDRAULIC EXCAVATOR KOMATSU**

By

Syaifuddin Zuhri

2-2152-006

MASTER'S DEGREE

in

MASTER OF MECHANICAL ENGINEERING
FACULTY OF ENGINEERING & INFORMATION TECHNOLOGY



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

Juni 2022

ABSTRACT

LAPPING MACHINE WITH ARDUINO FOR OVERHOUL
HYDRAULIC PUMP AT SMALL HYDRAULIC EXCAVATOR

By

Syaifuddin Zuhri

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

Dr. Ir. Henry Nasution, M.T Co-Advisor

SWISS GERMAN UNIVERSITY

Hydraulic excavators are generally used in the construction, forestry, agricultural and mining sectors for activities such as land clearing, cut & fill in road, bridge, and dam construction, spreading material in road construction, maintenance, pipe installation, canalling, loading onto trucks, and as a rock breaker/building. The treatment that is considered good is the treatment that produces the minimum possible down time but of course with the lowest possible maintenance cost. About 70% of damage to hydraulic equipment is caused by problems in maintenance and in the selection of hydraulic oil.

During the hydraulic pump overhoul work there are several work processes including the lapping cylinder block process with valve plate which takes a long time of about 16 hours this is because the lapping process is done manually by a mechanic. The lapping machine with arduino that is installed & operated properly in the hydraulic pump overhaul process can reduce lead time in the lapping process to be faster and more precise than the manual methode.

Keywords : Lapping Machine, Excavator, Overhoul, Hydraulic Pump, Piston Pump, Arduino

© Copyright 2022
by Syaifuddin Zuhri
All rights reserved

DEDICATION

I dedicated this research for My Family & UT School – PT United Tractors Tbk. Cabang
Banjarmasin

ACKNOWLEDGEMENTS

I Would like to thank to Mr. Dena Hendriana B.Sc, S.M., Sc.D and Dr. Ir. Henry Nasution, M.T and all Lecturers who have guided me while studying in Swiss German University. And also to Mr. Edhie Sarwono, Mr. Muhammad Hamdan Aziz, Mr. Donny Krestanto and the management of PT United Tractors Tbk who gave me the opportunity to take a master's degree.

TABLE OF CONTENTS

	Page
STATEMENT BY THE AUTHOR.....	2
ABSTRACT.....	3
DEDICATION.....	5
ACKNOWLEDGEMENTS.....	6
TABLE OF CONTENTS.....	7
LIST OF FIGURES.....	9
LIST OF TABLES.....	12
CHAPTER 1 – INTRODUCTION.....	13
1.1 Background.....	13
1.2 Research Problems.....	17
1.3 Research Objectives.....	17
1.4 Research Question.....	18
1.5 Hypothesis.....	18
CHAPTER 2 - LITERATURE REVIEW.....	19
2.1.Komatsu Hydraulic Excavator.....	19
2.2.Hydraulic Piston Pump.....	20
2.3.Overhaul Hydraulic Pump.....	26
2.4.Basic of Lapping.....	32
2.5.Basic of Arduino.....	37
2.6.DC Motor Fundamental.....	39
2.7.Proximity Sensor.....	42
2.8.Load Cell Sensor HX711.....	43
2.9.LCD Display.....	45

2.10.PWM Speed Control	48
2.11.Real Time Clock (RTC)	49
CHAPTER 3 – RESEARCH METHODS	50
3.1.Research Framework.....	50
3.2.Scope of Study	51
3.3.Time Frame of Research	51
3.4.Conceptual Design	51
3.5.Block Diagram	54
3.6.Tools and Materials	54
3.2.Flowchat Diagram	59
3.2.Wiring Diagram.....	60
CHAPTER 4 – RESULTS AND DISCUSSIONS.....	62
4.1.Initial Evaluation	62
4.2.Experimental Result	74
CHAPTER 5 – CONCLUSIONS AND RECCOMENDATIONS.....	80
GLOSSARY	82
REFERENCES	84
CURRICULUM VITAE.....	86
APENDIX.....	87

LIST OF FIGURES

Figures	Page
Figure 1. Classification of Hydraulic Excavators Komatsu.....	15
Figure 2. Cause of heavy equipment damage	14
Figure 3. Damage caused by errors in carrying out maintenance.....	15
Figure 4. Total work order (WO).....	16
Figure 5. Population unit small hydraulic excavator	16
Figure 6. The mechanic lapping manually	17
Figure 7. Powertrain small hydraulic excavator	19
Figure 8. Hydraulic equipment layout drawing.	20
Figure 9. In line axial piston pump – variable displacement.	22
Figure 10. In line axial piston pump – fixed displacement.	22
Figure 11. Bent axial piston pump – fixed displacement	20
Figure 12. Bent axial piston pump – variable displacement.	23
Figure 13. Radial piston pump – rotating piston	24
Figure 14. Main pump HPV 125+125 small hydraulic excavator	25
Figure 15. Cylinder block & valve plate.....	26
Figure 16. Classification maintenance heavy equipment.....	28
Figure 17. Management overhoul component heavy equipment.....	29
Figure 18. Basic lapping machine	33
Figure 19. Type of grinding paste.....	34
Figure 20. Roughness Ra micro (10-4)	37
Figure 21. Arduino mega 2560.	39
Figure 22. Structure DC Motor	40
Figure 23. DC series motor : schematic & wiring diagram	41
Figure 24. DC shunt motot : schematic & wiring diagram	41
Figure 25. DC compound motor : schematic & wiring diagram.	42
Figure 26. Proximity sensor E18-D80NK.	43
Figure 27. Proximity sensor E18-D80NK pin description and installaton.	44
Figure 28. Proximity sensor E18-D80NK logic utput.	44

Figure 29. Load cell sensor HX711.	45
Figure 30. Board schematic load cell sensor HX711.....	46
Figure 31. LCD display 20x4 I2C.....	47
Figure 32. Speed control dimmer	48
Figure 33. RTC DS3231	49
Figure 34. Flowchart research framework.	50
Figure 35. Process getting flatness.....	52
Figure 36. Block diagram lapping machie with arduino mega 2560.....	54
Figure 37. Flow diagam process lapping machine	59
Figure 38. Circuit diagram lapping machine with arduino.	60
Figure 39. Load cell sensor reading	65
Figure 40. Motor speed sensor reading	66
Figure 41. Dimention box display	67
Figure 42. Power supply main motor & swing motor	68
Figure 43. Box display view.	68
Figure 44. Inside box view	69
Figure 45. Front lapping machine tool view.....	70
Figure 46. Lower main motor & swing motor view	70
Figure 47. Side lapping machine tools view	71
Figure 48. Chuck bubut location.....	71
Figure 49. Proximity sensor location	72
Figure 50. Load cell sensor installation	72
Figure 51. Box display location.	73
Figure 52. Display menu lapping machine.	73
Figure 53. First state visual check cylinder block.....	74
Figure 54. Display flatness 1-15%.....	75
Figure 55. Display process lapping flatness 1-15%.....	76
Figure 56. Before & after lapping flatness 1-15%.....	76
Figure 57. Second state visual check cylinder block.	77
Figure 58. Display flatness 16-30%.....	77
Figure 59. Third state visual check cylinder block	78

Figure 60. Display flatness 31-50%	79
Figure 61. Display process lapping flatness 31-50%.....	79
Figure 62. Lapping result with flatness from 31-50% to 1-15%.	79
Figure 63. Before & after lapping flatness 31-50%.....	80

LIST OF TABLES

Table	Page
Table 1. Pinout LCD Display	47
Table 2. RTC DS3231 specification	49
Table 3. Time Frame of research	51
Table 4. Simulation conditions	51
Table 5. List of grade pasta grinding	53
Table 6. List of tools	55
Table 7. List of materials	58
Table 8. List of material and equipment	61
Table 9. Load cell reading	64
Table 10. Result of load cell sensor test	65
Table 11. Simulation condition	74
Table 12. First state simulation result	76
Table 13. Second state simulatiion result	77
Table 14. Third satate simulation result	80

STATEMENT BY THE AUTHOR

Name of Student : Yudhistira Nizar
Student ID : 22152008
Faculty : Engineering & Information Technology
Study Program : Master of Mechanical Engineering – Mechatronics concentration
Date of Defense : 05 July 2022
Thesis Title : Automatic Warning System to Prevent Collisions and Provide a Safe Distance between Heavy Duty-Trucks

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.



Yudhistira Nizar
(Name of Student)

Approved by:
Date: 18 July 2022



Dena Hendriana, B.Sc., S.M., Sc.D.
(Thesis Advisor)



Dr. Ir. Hanny J. Berchmans M.T., M.Sc.
(Thesis Co-Advisor)

Acknowledged by:
Date: 18 July 2022



Dr. Maulahikmah Galinium, S.Kom, M.Sc.
(Dean of Faculty of Engineering & Information Technology)

**AUTOMATIC WARNING SYSTEM TO PREVENT COLLISIONS
AND PROVIDE A SAFE DISTANCE BETWEEN HEAVY DUTY-TRUCKS**

By

Yudhistira Nizar
22152008

MASTER'S DEGREE
in

MASTER OF MECHANICAL ENGINEERING
FACULTY OF ENGINEERING & INFORMATION TECHNOLOGY



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

June 2022

ABSTRACT

AUTOMATIC WARNING SYSTEM TO PREVENT COLLISIONS AND PROVIDE A SAFE DISTANCE BETWEEN HEAVY DUTY-TRUCKS

By

Yudhistira Nizar

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

Dr. Ir. Hanny J. Berchmans M.T. M.Sc., Co-Advisor

SWISS GERMAN UNIVERSITY

Heavy equipment operating in mining areas is heavy duty-trucks, which function as a means of transporting material over short to long distances. Operating and producing on target is the core goal, but safety is a key factor in achieving it. See the safety performance statistics on one of the customers of PT United Tractors Tbk. the data obtained that work accidents due to unsafe conditions and unsafe acts continue to increase every year, including collisions between heavy duty-trucks caused by the operator's lack of anticipation in maintaining a safe distance while driving. This causes a loss of production time due to the collision accident investigation process and the emergence of the need for impromptu equipment repair costs. If the accident causes the fatality, the government can revoke the mining operation permit and harm many parties. Based on this, researchers need to develop technology-based tools that can prevent collision accidents in mining areas. In general, the working mechanism of the developed tool uses a GPS (global positioning system) to read the position of the heavy duty-trucks against the satellite, and then translate it into a location on the earth's surface in the form of longitude, latitude, and altitude data. This data is sent to other heavy duty-trucks using radio frequency signals via LoRa (Long Range). The operator can see the distance between heavy duty-trucks while driving and a warning sound will activate automatically when an unsafe distance between heavy duty-trucks is detected. Distance data will be stored in a memory card and can be downloaded wirelessly using a web server to be followed up in the coaching process by supervisors regularly.

Keywords: heavy equipment, heavy duty-trucks, unsafe acts, anticipation, collision, safe distance, global positioning system, long-range, wireless

© Copyright 2022
by Yudhistira Nizar
All rights reserved

DEDICATION

I dedicate this study to my beloved family, UT School, and PT United Tractors Tbk.
Allah gives me everything.

ACKNOWLEDGEMENTS

I would like to thank Mr. Dena Hendriana, B.Sc., S.M., Sc.D. and Mr. Dr. Ir. Hanny J. Berchmans M.T. M.Sc. as advisors and co-advisors and to all lecturers who always provide support and guidance during the learning process and the preparation of this research. I would also like to thank Mr. Edhie Sarwono, Mrs. Endang Tri Handajani, Mr. Hamdan Aziz, Mr. Bayu Iman Sentosa, Mr. Achmad Muslimin, Mr. Wahono as well as the entire management of PT United Tractors Tbk., My Best Partner in Corporate University Berau who always support me, and UT School who have given the opportunity to join the master degree program.

TABLE OF CONTENTS

	Page
STATEMENT BY THE AUTHOR	2
ABSTRACT	3
DEDICATION	5
ACKNOWLEDGEMENTS	6
TABLE OF CONTENTS	7
LIST OF FIGURES	9
LIST OF TABLES	12
CHAPTER 1 - INTRODUCTION	13
1.1 Background	13
1.2 Research Problem	18
1.3 Objectives	18
1.4 Research Questions	18
1.5 Significant Study	18
1.6 Hypothesis	19
1.7 Assumptions	19
CHAPTER 2 - LITERATURE REVIEW	20
2.1 Theoretical Perspectives	20
2.1.1 Heavy Duty-Trucks (HD785-7) Introduction.....	20
2.1.2 Correlation of Gear Position and Speed	23
2.1.3 Travel Performance	24
2.1.4 Safety Operation of Heavy Duty-Trucks.....	25
2.1.5 Human and System of Equipment Response	30
2.1.6 Understanding of Place, Position, and Location	33
2.1.7 GPS (Global Positioning System)	35
2.1.8 LoRa (Long Range).....	37
2.1.9 XAMPP – Web Server	40
2.2 Previous Studies	43
CHAPTER 3 – RESEARCH METHODOLOGY	47
3.1 Research Framework	47
3.2 Scope Of Study	48
3.3 Conceptual Design	48
3.4 Flow Diagram	53

3.5	Block Diagram	54
3.6	Materials and Equipment	57
3.6.1	Arduino Microcontroller	57
3.6.2	LoRa SPI Module	58
3.6.3	NodeMCU Module	59
3.6.4	Step-Down Module	60
3.6.5	Magnetometer (Digital Compass Sensor)	61
3.6.6	RTC Module	62
3.6.7	GPS Module	63
3.6.8	GSM GPRS Module	64
3.6.9	Memory Micro SD Card Module	65
3.6.10	Relay Module	66
3.6.11	LCD TFT Display 3.5”	66
3.6.12	Arduino IDE	67
CHAPTER 4 – PROTOTYPING & TEST RESULT		68
4.1	Initial Evaluation	68
4.2	Device Assembly	71
4.3	Experimental Result	76
4.3.1	Testing of Tool when installed on the machine	76
4.3.2	Experimental Results to Send Warning Messages by GSM	79
4.3.3	Experimental Results to Download Data from XAMPP	79
4.4	Prevention of Collisions Between HD78-7 Using a Warning System	81
4.4.1	Warning System is Active When The Distance Between HD785-7 is below The Safe Limit	81
4.5	Budget Usage	83
CHAPTER 5 – CONCLUSIONS AND RECCOMENDATIONS		84
5.1	Conclusions	84
5.2	Recommendations	85
GLOSSARY		86
REFERENCES		87
CURRICULUM VITAE		89

LIST OF FIGURES

Figures	Page
Figure 1. Variant Heavy Duty-Trucks in UT's Product	12
Figure 2. Machine Population End of 2021	13
Figure 3. Crash Accident in Mining Area and Cause Fatality	13
Figure 4. Inspection and Hazard Data 2019 - 2021	14
Figure 5. Incident Rootcause Analysis Q1 2021 vs 2020	14
Figure 6. Safe Driving Distance.....	15
Figure 7. Mining Operation	16
Figure 8. Dump Truck Movement Simulation.....	17
Figure 9. Size Dimensions HD785-7	19
Figure 10. Power Train Skeleton HD785-7	20
Figure 11. Working Mode in HD785-7	21
Figure 12. Torqflow Transmission HD785-7	22
Figure 13. Travel Performance Curve in Working Mode.....	23
Figure 14. Directions of Machine	25
Figure 15. Visibility from Operator's Seat	25
Figure 16. 24-M Radius Visibility	26
Figure 17. General View of Controls and Gauges in Cabin HD785-7	27
Figure 18. Function of Auto Retard Speed Control	28
Figure 19. Safe Driving Distance, Human and System Vehicle Response.....	30
Figure 20. Two Seconds Rule	30
Figure 21. Description of The Position.....	33
Figure 22. Geographic Coordinate System on The Spherical Earth's Surface	33
Figure 23. How GPS Works	34
Figure 24. Comparison of LoRa Base On Power Consumption and Range	36
Figure 25. Example of a Chirp Shape	37
Figure 26. XAMPP Control Panel v3.2.1	39
Figure 27. Arduino Two-Way Communication with Web Browser.....	40
Figure 28. XAMPP Access View via Control Panel	41

Figure 29. System Block Diagram (NEO-6M and SIM800)	42
Figure 30. Workflow Research Method.....	46
Figure 31. Concept of How The System Works	48
Figure 32. Location of The Tool in HD785-7.....	49
Figure 33. Main Components and Work Flow	49
Figure 34. Logic Diagram of Active Distance Detection Warning Buzzer	49
Figure 35. The Work of Tool in Workshop Area	51
Figure 36. The Work of Tool in Field Area.....	52
Figure 37. Flow Diagram of The Tool System	52
Figure 38. Block Diagram of The Tool.....	54
Figure 39. Arduino Mega 2560.....	56
Figure 40. LoRa Ra-02 SX1278 SPI Module	57
Figure 41. NodeMCU ESP8266	58
Figure 42. Step-Down DC to DC Voltage Converter LM2596S.....	59
Figure 43. Magnetometer HMC5883L	60
Figure 44. RTC DS3231	61
Figure 45. Specification of GPS NEO6MV2.....	62
Figure 46. GSM Module SIM800L	63
Figure 47. Memory Micro SD Card.....	64
Figure 48. Relay 24V One Channel	65
Figure 49. LCD TFT Display 3.5”	65
Figure 50. Main Display of Arduino IDE	66
Figure 51. Component Test and Evaluation Before Assembly.....	67
Figure 52. Tes GPS Sensor via Arduino IDE	67
Figure 53. Sample Point Conversion of GPS Sensor Readings via Google Map.....	68
Figure 54. LoRa Communication Sending Data.....	68
Figure 55. LoRa Communication Receive Data	69
Figure 56. NodeMCU Connection Function with WIFI.....	69
Figure 57. SIM 800L Connection Function with Arduino and Phone Number.....	70
Figure 58. Component Assembly Process	71
Figure 59. Assembled Tool View	71
Figure 60. Attribute Description on Hardware	72
Figure 61. Tool Screen Display via LCD TFT	72

Figure 62. Check Tool and Program in Arduino IDE.....	73
Figure 63. Initial for Check GPS and LoRa Communication (Transceiver)	73
Figure 64. Initial for Check WIFI Connection via NodeMCU	74
Figure 65. Hardware Display During Initial Setting.....	74
Figure 66. Hardware Display When LoRa Send and Receive Data	74
Figure 67. Testing Tool in Dump Truck HD785-7	76
Figure 68. Design Bracket Tool in Dump Truck HD785-7	76
Figure 69. Tool Installation Process in Dump Truck HD785-7.....	77
Figure 70. Tool Works in Dump Truck HD785-7	78
Figure 71. Incoming SMS Notification When Distance is not Safe	79
Figure 72. The Process Downloading Data Using WIFI	79
Figure 73. Display XAMPP Support Download Data	80
Figure 74. Mode Display in XAMPP and Data Download Results.....	80
Figure 75. Direct Application of Tools on HD785-7.....	81
Figure 76. Description of Tool Works According to Mode.....	81

LIST OF TABLES

Table	Page
Table 1. Property Damage in Heavy Duty-Trucks	15
Table 2. Gearshift Lever Position and Automatic Gearshifting Range	22
Table 3. Speed Range in Working Mode	24
Table 4. Sensor Comparison	32
Table 5. Comparison of Navigation System	35
Table 6. Correlation of spreading factor, bitrate and range in LoRa	38
Table 7. Logic table of Audible Warning Distance Detection.....	50
Table 8. Safe Distance Calculation for Program Settings on Arduino	53
Table 9. List of Component Specification	55
Table 10. Logical Sequence of Logger Distance Data and Message via GSM	55
Table 11. Specification of Arduino Mega 2560.....	56
Table 12. Specification of LoRa Ra-02 SX1278 SPI Module	57
Table 13. Specification of NodeMCU ESP8266	58
Table 14. Specification of Step-Down DC to DC Voltage LM2596S.....	59
Table 15. Specification of Magnetometer HMC5883L	60
Table 16. Specification of RTC DS3231	61
Table 17. Specification of GPS NEO6MV2	62
Table 18. Specification of GSM GPRS SIM800L.....	63
Table 19. Specification of Memory Micro SD Card Module	64
Table 20. Result of Tool Work in a Mining Area.....	78
Table 21. Conclusion of The Real Tools Application in HD785-7	82
Table 22. Component Details and Price Build Tool	83