

STUDY OF DESIGN AND FABRICATION OF DRIVING SIMULATOR

AZRUL HAFEZ BIN MOHAMAD

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SUPERVISOR DECLARATION

“I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design and Innovation).”

Signature :

Supervisor :

Date :

STUDY OF DESIGN AND FABRICATE DRIVING SIMULATOR

AZRUL HAFEZ BIN MOHAMAD

**This thesis is submitted as part of the fulfillment for the bestowal of Bachelor in
Mechanical Engineering (Design and Innovation) with Honours.**

**Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka**

JUNE 2013

DECLARATION

“I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged.”

Signature :

Author :

Date :

Special to
Beloved Mom and Dad

ACKNOWLEDGEMENT

First of all, I would like to thank god for giving me the opportunity and bless to complete my final year project. Besides, the most important thing is I would like to express my precious acknowledgement to my caring supervisor, Engr. Dr. Mohd. Azman Bin Abdullah for guiding and encouraging me in many ways on writing this thesis. Best acknowledge to En Junaidi and En Alizam, the one who help me on giving advice and support me on finish the project based on the planning schedule. I also not forget to all my classmate members who help me in finding the data regarding survey, Rahiman Salmi bin Rosdi, Muhammad Nur Aliff bin Saji, Akmal Hakim bin Shuhaimi, Riswan Haramadan bin Muhammmad Isa and Nur Ida Laila binti Bakhtiar and fellow friend who direct or indirectly helping me. Thank very much to their concern, encouragement and understanding about my difficulty on successfully complete my project. Lastly special acknowledge for most important persons, my beloved family, my mom, dad and my sibling who support me from long distance with prayer without them, i would not success this project starting to the end of the final year project.

ABSTRAK

Simulator pemanduan adalah sejenis peranti yang digunakan secara meluas dalam semua kehidupan hari ini seperti pembelajaran dan amalan sebelum mendedahkan kepada dunia pemanduan. Simulator pemanduan adalah kombinasi panduan dalam simulator yang mempunyai spesifikasi seperti pemanduan sebenar. Terdapat banyak jenis simulator yang boleh di lihat di dalam industri dan akademik seperti simulator penerbangan dan simulator pemanduan. Spesifikasi peranti ini adalah ia mempunyai pemasangan bahagian yang berfungsi untuk menghasilkan gerakan berdasarkan penggunaan atau pemanduan. Banyak perkara yang terlibat dalam simulator pemanduan ini seperti peranti penggerak, kerusi, skrin dan peranti kenderaan (stereng, pedal dan penukaran gear). Fasa merekabentuk adalah perkara paling penting dalam membuat casis simulator pemanduan manakala sebahagian yang lain hanya fabrikasi, pemasangan dan menjalankan analisis terhadap struktur simulator. Projek ini melibatkan reka bentuk, fabrikasi dan pemasangan serta analisis reka bentuk casis. Penyelidikan tentang sedia ada pembangunan simulator pemanduan lain menjadi medium untuk diperbaiki dalam projek ini dalam membuat simulator memandu dan analisis pula melibatkan statik dan lain-lain analisis mekanikal yang penting. Selain itu, pembangunan simulator pemanduan adalah perkara yang paling penting untuk mencapai objektif projek ini. Selain itu, projek ini juga melaksanakan subjek reka bentuk yang telah dipelajari melalui subjek terdahulu dan perkara lain juga dapat dikumpulkan daripada pembangunan simulator pemanduan. Simulasi terutamanya adalah perisian atau alat yang digunakan untuk merangsang atau menjalankan simulator. Cadangan simulator pemanduan ini adalah pelaksanaan ke arah belajar dan latihan terutama kepada akademi memandu dan juga kajian yang lebih baik untuk prestasi kereta di dalam industri automotif.

ABSTRACT

Driving simulator is the types of the device that widely used in all aspect of life nowadays such as learning and practice before expose to the world of driving. The driving simulator is the combination of the driving inside the simulator which has specification of the real driving. Many types of the simulator can be seen in industries and academic such as flight and driving simulator. The specification of this device is it has the part installation that function to produce motion based when use or drive. Many things include in this driving simulator such as actuator, seat, screen and vehicle device (steering wheel, pedal and gear shifter). Designing phase is the important thing in making chassis of the driving simulator while other part only fabricate, installation and run to analysis the structure of the simulator. This project is involving the design, fabricate and installation as well as the analysis of the chassis design. The research about existing of the other development driving simulator become the tool to be improved in this project of making driving simulator and analysis involve is static and other important mechanical analysis. Besides that, driving simulator development is the most important thing in order to achieve objective of this project. Moreover, this project also implement the design subject that have been learned through the courses and other thing also can be gathered from develop driving simulator. Simulation especially is the software or device that used to stimulate or run the simulator. The suggestion of this driving simulator is implementation towards learning and practicing especially for driving academy and better research through the performance of the car automotive industries.

CONTENT

CHAPTER	CONTENT	PAGE
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRAK	v
	ABSTRACT	vi
	CONTENT	ix
	LIST OF TABLE	x
	LIST OF FIGURE	xi
	LIST OF SYMBOL	xii
	LIST OF ABBREVIATIONS	xiii
CHAPTER 1	INTRODUCTION	1
	1.1 Project Background	1
	1.2 Project Importance	2
	1.3 Objective	2

1.4	Scope	2
1.5	Summary	3
CHAPTER 2 LITRATURE REVIEW		4
2.1	Introduction	4
2.2	Driving Simulator	5
2.2.1	Low Level Driving Simulator	5
2.2.2	Mid Level Driving Simulator	6
2.2.3	High Level Driving Simulator	7
2.3	Driving Simulator Development	8
2.3.1	Physical Component	8
2.3.2	Software	8
2.3.3	Chassis	9
2.3.4	Seat	9
2.4	Design of Driving Simulator	10
2.5	CAD Software	11
2.6	Design Process	13
2.6.1	House of Quality	14
2.6.2	Morphological Chart	15
2.6.3	Weighted Decision Matrix	16
2.7	Installation Equipment	17

2.7.1	Logitech G27	17
2.7.2	Sparco Millennium 3	18
2.7.3	Actuator SCN5	19
2.8	Fabrication	20
2.8.1	MIG Welding	21
2.8.2	Bolt and Nuts	22
CHAPTER 3 METHODOLOGY		23
3.1	Introduction	23
3.2	Gantt Chart	23
3.3	Flow Chart	24
3.4	Concept Design Selection	29
3.4.1	Detail Design	30
3.4.2	CAD Drawing	31
3.4.3	Morphological Chart	34
3.4.4	Weighted Decision Matrix	35
3.5	CAD Drawing	36
3.5.1	Basic Material	36
3.5.2	Shape Material	38
3.5.3	Mounting Assembly	45
3.5.4	Full Assembly	47

3.6	Fabrication Process	49
3.6.1	Basic and Shape Material	49
3.6.2	Mounting	51
3.6.3	Welding	53
3.6.4	Finishing	55
3.6.5	Installment	57
3.7	Survey Analysis	60
CHAPTER 4 RESULT		61
4.1	Design Analysis	61
4.1.1	Pressure	65
4.1.2	Factor of Safety	67
4.1.3	Tabulate Data	69
4.1.4	Weighted Decision Matrix	89
4.1.5	Prototype Ergonomic Evaluation	92
CHAPTER 5 DISCUSSION		100
5.1	Introduction	100
5.2	Analysis	101
5.3	Ergonomic Survey	102

CHAPTER 6 CONCLUSSION AND RECOMMENDATION	105
6.1 Conclusion	105
6.2 Recommendation	106
6.2.1 Fabrication and Material	106
6.2.2 Ergonomic Study	107
REFERENCE	108
APPENDICES	116

LIST OF TABLE

NO.	TITLE	PAGE
2.1	The example of HOQ	14
2.2	The example of Morphological Chart	15
2.3	The example Weighted Decision Matrix	16
3.1	Gantt chart for PSM 1	25
3.2	Gantt chart for PSM 2	26
3.3	Morphological chart of driving simulator	34
3.4	Weighted Decision Matrix of driving simulator	35
4.1	Weighted matrix factor	69
4.2	Calculated weighted decision matrix	89
4.3	Survey for ergonomic product of driving simulator	93
4.4	Score and respond all features.	98
4.5	Score and respond for seat position.	99

LIST OF FIGURE

NO.	TITLE	PAGE
2.1	Low level VDI driving simulator	6
2.2	Mid level driving simulator, NTNU/SINTEFF	6
2.3	High level driving simulator, NADS	7
2.4	Part Design under Mechanical Design	12
2.5	Generative Structural Analysis under Analysis and Simulation	13
2.6	A set of Logitech G27	18
2.7	Sparco Millennium 3	19
2.8	Actuator SCN5	20
2.9	MIG welding	21
2.10	Bolt and Nut	22
3.1	Flow Chart for PSM 1	27
3.2	Flow Chart for PSM 2	28
3.3	Detail design based on concept design Vision Racer D-Box VR3	30
3.4	First CAD Design	31
3.5	Second CAD Design	32
3.6	Third CAD Design	33

3.7	Hollow mild steel	36
3.8	Drafting of hollow mild steel	37
3.9	Angle hollow mild steel	38
3.10	Drafting of angle hollow mild steel	39
3.11	Mild steel plate	40
3.12	Drafting of mild steel plate	41
3.13	Bolt	42
3.14	Nut and washer	42
3.15	Drafting of bolt	43
3.16	Drafting of nut and washer	44
3.17	Explode view of mounting on seat position	45
3.18	Assembly view of mounting on seat position	45
3.19	Explode view of mounting on pedal position	46
3.20	Assembly view of mounting on pedal position	46
3.21	Explode view of all part	47
3.22	Assembly view of all part	48
3.23	Cutting process by using bench saw	50
3.24	Cutting process by using cutting disc	50
3.25	Drilling on mounting using hand drill	51
3.26	Mounting assembles at seat position	52
3.27	Mounting assembles at pedal position	52
3.28	Spot welding process	53
3.29	Full welding process	54
3.30	Full body complete welding	54
3.31	Grinding process	55

3.32	Painting process	56
3.33	Full body complete finishing	56
3.34	Installation of pedal	57
3.35	Installation of gear knob	58
3.36	Installation of steering wheel	58
3.37	Installation of seat	59
3.38	Prototype complete installation	59
4.1	Force and fix constraint on design first	62
4.2	Force and fix constraint on design second	63
4.3	Force and fix constraint on design third	64
4.4	Pressure analysis or von mises stress on design first	65
4.5	Pressure analysis or von mises stress on design second	66
4.6	Pressure analysis or von mises stress on design third	66
4.7	Percentage versus features	94
4.8	Percentage versus features	95
4.9	Percentage versus ranking	96
5.0	Percentage versus ranking	97
5.1	Percentage versus ranking	97

LIST OF SYMBOL

ASTM A36	=	properties of low carbon steel
ASTM A27	=	properties of low carbon steel
M8	=	bolt thread dimension
M6	=	bolt thread dimension

LIST OF ABBREVIATIONS

CAD	=	Computer aided design.
CATIA	=	Computer aided three dimensional interactive application.
SOLIDWORK	=	Computer aided design.
PSM	=	Projek sarjana muda.
VDI	=	Virtual desktop infrastructure.
NADS	=	National advanced driving simulator.
NTNU	=	Norwegian university of science and technology

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

IT technology is expanding briskly from year to year, and is also a necessity that can't be denied in the present age. No matter wherever we go, it is highly emphasized on IT technology as an example like driving simulator game center which is particular places at a very large shopping mall and multi-storey called "Arcade".

As we know, the simulator expand overseas extensive and well received among driving schools as to facilitate on teaching and learning process for motorists who want to get a driving license. In Malaysia, the driving simulator is not applied in driving school, high likely due to financial factors and does not have enough space.

Even in Malaysia only driving simulator focused in the area of the shopping center only meant for entertainment and spend free time while waiting for their parents shopping in a long time. Driving simulator technology in the "arcade" is just focused on driving the static and does not affect the movement of embracing the true driving.

For undergraduate project at this time, I will produce a product known as driving simulator with actuator. Driving simulator will be produced consisting of arcade driving simulator concepts that already have on outside the country, but there is a change in

some aspect of the simulator framework, gear position, steering wheel and pedals and appropriate concept of real driving. Screens that used also become one of the impacts in real driving also where movement occurs in turn, brake and high speed. Involved also gear shifter, steering, wheel and Recaro seat and static barrier under the cockpit.

1.2 PROJECT IMPORTANT

This project is important in order to learn about how the product research, development and simulation is done. The thing that learns is the design process, fabrication, installation and analysis of the project as well as the improvement from the previous research. Besides it become the main subject of the last year degree program and the important thing that need to be done and carried out along the undergraduate project requirement from the university.

1.3 OBJECTIVE

The first objective of this project entitle design and fabricate driving simulator is to design the driving simulator. The second objective is to develop and fabricate driving simulator.

1.4 SCOPE

In this project, the most important thing to be taken into account regarding the final year project is design and analysis driving simulator using commercial CAD software. For example is CATIA, SOLIDWORK and others. Other than that is

fabricated and install driving component into driving simulator. The analysis includes static analysis and prototype ergonomic evaluation.

1.5 SUMMARY

The more development in technologies, people are becoming lazy and all the developed technology having advantages and disadvantages. Especially to the Malaysian drivers, among of the car drivers do not follow the rules of prudent driving cars respectively against time in order to achieve something, but that attitude will lead to unexpected accidents. Thus, the driving simulator produced to allow motorists who want to set foot into the world of road driving will be trained properly and prudently in order to reducing road accidents. In addition the driver can also feel the real driving in the driving simulator which having a significant impact in change gear, pressing the clutch, turning, braking and pressing oil for maximum velocity. Besides, driving simulator also can train drivers in more efficient and confident in order to face real driving situation. The trainer also can monitor the driving behavior of the driver and fixed it when on the right way and avoid the wrong behavior when in the training facility. As example when the candidate taking driving license test, the training in driving simulator need to be done first before faced the real driving license test so that he or she become more confident when taking test or facing reality of driving on the road by himself or herself. Thus in this project it more on the design the driving simulator, applying the design process, fabricate, installation and analysis of the chassis driving simulator using commercial CAD software that is CATIA V5. Besides, the improvement or added value form the existing design is included in order to build new design or modification of existing chassis design.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this project the main thing to considered is the effectiveness on the analysis using CAD software especially CATIA which fulfill the customer criteria of the toughness and strong joint of the design structure. The literature review include on the previous design of the driving simulator, tools to be installment, driving simulator type and the material involve in build the design structure. All the information regarding the literature review is gathered from the website journal and books. This is important to be review so that in this design can be improved towards the specific needs of the customer as well as the engineering characteristics of this simulator design.

2.2 Driving Simulator

Driving Simulator is the combination of the word driving and simulator which means that a machine which operate certain environmental and other condition for purpose of training and experimentation. In other words simulator is called simulation which means that reproduce from the actual world process or operation in cycle time.

Besides that, driving simulator invention is starting from the Second World War which motive to train many personal for handling tactical war machinery. After that in 1960s the development applies in research, behavior and road environment (Roberts, 1980). Then the development applies in automotive industries and university for purpose of learning (Blana, 1996). There are many types of simulator present nowadays example car, truck and bus. In this type, this simulator spread into three parts which is low level, mid level and high level.

2.2.1 Low Level Driving Simulator

In this type of simulator only contains pedal, gear, steering wheel and pc. Easy to get because of the cost is cheap and affordable for school to be used as driving license academy. The example of VDI the low level driving simulator is most advanced video games and arcade which situated at the shopping complex (Engen, 2008). **Figure 2.1** is the example of low level driving simulator.