UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STUDY ON AUTOMATION OF GENERATING CAD MODEL FOR AUTOMOTIVE PART (BUMPER GRILLE)

ELSTON MANSON
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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (AUTOMOTIVE TECHNOLOGY) WITH HONOURS

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Elston Manson

Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

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ELSTON MANSON

A thesis submitted
in fulfilment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

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2022

DECLARATION

I declare that this thesis entitled “Study on Automation of Generating CAD Model for Automotive Part (Bumper Grille)” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : ELSTON MANSON

Date : 26/1/2022

APPROVAL

I hereby declare that I have checked this thesis, and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

Signature : 

Supervisor Name : TS. DR. MOHD BASRI BIN ALI

Date : 26/1/2022

DEDICATION

To my beloved parents, Manson Gunting and Supiah Simin who have tirelessly and endlessly gave support to me to complete this degree since day one. Not to forget my supervisor who have been guiding me throughout the entire journey of the final year project. To all my friends that have helped to motivate me and other people of UTeM that have directly or indirectly helped towards the completion of this project.

ABSTRACT

The application of CAD in the automotive industry has become an important role in various department such as the manufacturing, analysis, and simulation. Although the usage of CAD has improved greatly for the industries, arise challenges such as keeping up with customers' demands in short period time while maintaining quality standards are faced by the industries. In CAD systems, an automation feature provides huge advantages towards companies in terms of time efficiency and cost reduction. Additionally, automation provides superior results in repetitive works, especially involving with accuracy, precision, and reliability. Therefore, this project aims to develop an automation program which demonstrates its ability in automating models. There are two important stages of the development process which include the model creation and programming works. The modelling will be performed first with macro recording enabled. As the modelling process is carried out, the macro will record the script for the model which can be used for generating or automation purposes. Identification of parameters will be then performed to pinpoint which dimension should be fixed or changeable. The obtained model script from the macro recording process will be then edited accordingly in line with the known changeable parameters. The final developed program should be able to perform changes of parameters of three different model designs according to user inputted values with a user interface. Additional features such as blueprints and auto default value input function also should aid the user during the usage of the developed program. The blueprints will aid the user visually in identifying parameters of the model while the auto default value input function helps user to input the default parameter values of the model automatically when experimenting multiple design generations.

ABSTRAK

Aplikasi CAD dalam industri automotif telah menjadi peranan penting dalam pelbagai jabatan seperti pembuatan, analisis, dan simulasi. Walaupun penggunaan CAD telah memberikan kesan positif kepada industri, cabaran baharu seperti memenuhi permintaan pelanggan dalam jangka waktu yang singkat sambil mengekalkan kualiti, dihadapi oleh industri. Dalam sistem CAD, ciri seperti automasi memberikan kelebihan besar kepada syarikat dari segi kecekapan masa dan pengurangan kos. Selain itu, automasi memberikan hasil yang baik dari segi tugasan yang berulang, terutama yang melibatkan ketepatan dan kebolehpercayaan. Oleh itu, projek ini bertujuan untuk mencipta program automasi yang mampu mengotomatisasi model. Terdapat dua peringkat penting dari segi pembangunan proses yang merangkumi pemodelan dan kerja pengaturcaraan. Pemodelan akan dilakukan terlebih dahulu dengan rakaman 'macro' diaktifkan. Ketika proses pemodelan dilakukan, 'macro' akan merakam skrip pembinaan model dan kemudian digunakan untuk tujuan automasi. Pengenalpastian spesifikasi akan dilakukan untuk menentukan dimensi yang boleh diubah atau ditetapkan. Skrip model yang diperoleh dari proses rakaman 'macro' kemudian akan diubahsuai sejajar dengan dimensi atau spesifikasi yang dapat diubah. Hasil program dicipta harus dapat melakukan perubahan dari segi dimensi atau spesifikasi untuk tiga model berlainan apabila dimasukkan nilai. Ciri tambahan seperti pelan dan fungsi input nilai asal automatik juga harus membantu pengguna semasa penggunaan program yang dibangunkan. Fungsi pelan akan membantu pengguna secara visual dalam mengenal pasti dimensi model manakala fungsi input nilai asal automatik membantu pengguna memasukkan nilai dimensi asal model secara automatik apabila membuat beberapa generasi model.

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TABLE OF CONTENTS

		PAGE
DECLARATION		
APPROVAL		
DEDICATION		
ABSTRACT		**i**
ABSTRAK		**ii**
ACKNOWLEDGEMENTS		**iii**
TABLE OF CONTENTS		**iv**
LIST OF TABLES		**vi**
LIST OF FIGURES		**vii**
LIST OF SYMBOLS AND ABBREVIATIONS		**x**
LIST OF APPENDICES		**xi**
CHAPTER 1	**INTRODUCTION**	**1**
1.1	Background	1
1.2	Problem Statement	3
1.3	Research Objective	4
1.4	Scope of Research	4
CHAPTER 2	**LITERATURE REVIEW**	**6**
2.1	CAD (Computer Aided Design)	6
2.2	Automation	7
2.3	Automation Applications in CAD	7
2.4	CATIA (Computer-Aided Three-Dimensional Interactive Application)	8
2.5	Infrastructure of CATIA	9
2.6	Macro Programming	12
2.7	Visual Basic (VB)	13
	2.7.1 Visual Basic for Applications (VBA)	14
	2.7.2 VBScript	14
2.8	CATScript, CATVBA, CATVBS	15
2.9	Application of CATIA Macro in Generating CAD Model	15
	2.9.1 Dialogue Boxes	15
	2.9.2 Automation Process	16
2.10	CFD (Computational Fluid Dynamics)	16
2.11	Related Research on CAD Programming	17
2.12	Related Research on Airflow CFD Analysis	21

CHAPTER 3 METHODOLOGY 22
3.1 Introduction 22
3.2 Automation and CFD Process 22
3.3 Project Requirements 27
3.3.1 Bumper Grille Model 27
3.3.2 CATIA System Requirements 28
3.3.3 Modelling Process in CATIA 29
3.3.4 Macros Tool, Automation Development 29
3.4 CFD Analysis Process 32
3.4.1 Fixed Parameters for CFD Analysis 34

CHAPTER 4 RESULTS AND DISCUSSION 37
4.1 Introduction 37
4.2 Coding Development 37
4.2.1 Parameter Analysis 40
4.3 Development of 'UserForm' application 43
4.4 Execution and Result of Developed Program 48
4.5 Airflow Analysis 51
4.5.1 Design 1 51
4.5.2 Design 2 54
4.5.3 Design 3 57
4.6 Airflow Results 60

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS 62
5.1 Introduction 62
5.2 Conclusion 62
5.3 Recommendations 63
5.4 Project Potential 64

REFERENCES 65

APPENDICES 68

LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1	Related research on CAD Programming	19
Table 3.1	CATIA software requirements (Tickoo, 2016)	28
Table 3.2	Suitable parameter for automation process	30
Table 3.3	SOLIDWORKS 2021 software requirements	33
Table 3.4	Standard Parameter Values of Bumper Grilles	35
Table 3.5	Maximum Parameter Values of Bumper Grilles	35
Table 3.6	Minimum Parameter Values of Bumper Grilles	35
Table 3.7	Parameters of SOLIDWORKS 2021 – Flow Simulation	36
Table 4.1	Different parameter values for Design 1	49

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1	Overview of CATIA's Infrastructure (Dassault Systemes, 1999-2009)	10
Figure 2.2	Part Document Automation Objects (Dassault Systemes, 1999-2009)	11
Figure 2.3	An example of a message box created using a notepad and VBS.	14
Figure 2.4	Example of InputBox & MsgBox	16
Figure 3.1	Basic CAD model automation process flow	23
Figure 3.2	Details of automation development process flow	24
Figure 3.3	Basic flowchart of CFD analysis process	26
Figure 3.4	2016 Nissan Navara grille	28
Figure 3.5	The first sample model for reference	29
Figure 3.6	A sample model with identified parameters	30
Figure 3.7	The Visual Basic Application	31
Figure 3.8	Line script for determining the number of grill bar instances.	31
Figure 3.9	The User Interface for users to input values for their desired grill design.	32
Figure 3.10	A message box which tells user if they have entered an out-of-range value.	32
Figure 3.11	The virtual wind tunnel box	33
Figure 3.12	Bumper grille model inside the virtual tunnel	33
Figure 3.13	Meshing of bumper grille	34
Figure 4.1	Design 1	38
Figure 4.2	Design 2	38
Figure 4.3	Design 3	38

Figure 4.4 Numerous length constraints added for a single main bar 42

Figure 4.5 Initial stage of *Userform* for users to choose their preferred grille design. 44

Figure 4.6 Second stage of '*Userform'* for users to insert their desired parameter values of grille design. 45

Figure 4.7 Example of a bumper grille design 1 blueprints 46

Figure 4.8 Side by side view of both *'Userform'* 47

Figure 4.9 All default values are entered 47

Figure 4.10 Design 1 (A) 50

Figure 4.11 Design 1 (B) 50

Figure 4.12 Results of various parameters for 3 different designs 51

Figure 4.13 Design 1 standard 51

Figure 4.14 Design 1 maximum 52

Figure 4.15 Design 1 minimum 52

Figure 4.16 Airflow velocity for Design 1 standard 52

Figure 4.17 Airflow velocity for Design 1 maximum 53

Figure 4.18 Airflow velocity for Design 1 minimum 53

Figure 4.19 Design 2 standard 54

Figure 4.20 Design 2 maximum 54

Figure 4.21 Design 2 minimum 54

Figure 4.22 Airflow velocity for Design 2 standard 55

Figure 4.23 Airflow velocity for Design 2 maximum 55

Figure 4.24 Airflow velocity for Design 2 minimum 56

Figure 4.25 Design 3 standard 57

Figure 4.26 Design 3 maximum 57

Figure 4.27 Design 3 minimum 57

Figure 4.28 Airflow velocity for Design 3 standard 58

Figure 4.29 Airflow velocity for Design 3 maximum 58

Figure 4.30 Airflow velocity for Design 3 minimum 59

Figure 4.31 Maximum achieved airflow velocity of bumper grille models 60

Figure 4.32 Maximum achieved mass flow rate of bumper grille models 60

LIST OF SYMBOLS AND ABBREVIATIONS

⇽	-	Inheritance
API	-	Application Programming Interface
2D	-	Two-dimensional
3D	-	Three-dimensional
CAA	-	Computer Aided Architecture
CAD	-	Computer Aided Design
CADAM	-	Computer-Augmented Design and Manufacturing
CAE	-	Computer Aided Engineering
CAM	-	Computer Aided Manufacturing
CATIA	-	Computer Aided Three-dimensional Interactive
CFD	-	Computational Fluid Dynamics
GB	-	Gigabytes
GUI	-	Graphical User Interface
MIT	-	Massachusetts Institute of Technology
PhD	-	Doctor of Philosophy
PLM	-	Product Lifecycle Management
RAM	-	Random Access Memory
SP1	-	Service Pack 1
VB6	-	Visual Basic 6.0
VBA	-	Visual Basic for Application
VB	-	Visual Basic
VBS	-	Visual Basic Script
VBScript	-	Visual Basic Script

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
APPENDIX A	Gantt chart	68
APPENDIX B	Complete coding for automation program	69

CHAPTER 1

INTRODUCTION

1.1 Background

The automotive industry has been advancing throughout the years as it became more accessible and widely available to the consumers throughout the world. Automotive relates with motor vehicles, lorries, buses, or even specialized purpose vehicles such as tractor, excavator, and backhoe. The birth of automotive was started by the development of a first gasoline engine by Carl Benz in 1879. It was proven successful and has led him to create a better car and improve more (Daimler, 2021). As more companies and industry has started to produce more gasoline-powered vehicles, several challenges are present during development. Examples of challenges during development are such as design limitations, time constraint, high cost, high production failure, quality control issues and many more. While companies and industry have done their best in curbing these challenges, one of the most notable innovations which has turn the impossible into a dream come true was the introduction of Computer Aided Design.

The earliest CAD timeline which in the year of 1957 shows the first commercial numerical control programming system, nicknamed 'PRONTO' developed by Patrick Hanratty (Shafie, 2017). Afterwards in 1960, Sketchpad was developed by Ivan Sutherland which was marked as the beginning of CAD industry (Bi & Wang, 2020). From previous design developments to the latest, CAD has helped the industry in making improvements overtime as CAD software are being constantly updated with latest features and tools. CAD software such as CATIA, SolidWorks, ANSYS, Autodesk and many more are examples of

capable modelling software which helps engineers or designers in 2D or 3D modelling spaces. While modelling software are now capable of producing complex shapes and designs, it does take a toll on a user's ability to recreate a complex model repeatedly. As the technology of CAD enables wider range of complex products, the number of parameters of a complex model has led to memory and graphics intensive tasks which in turn, increases development time (Shafie, 2017). Therefore, the need of automation process was then introduced into the CAD space (Kreis, Hirz, & Rossbacher, 2020).

Thanks to Microsoft, the company has developed a programming language which named 'Visual Basic'. The programming language provides numerous features to CAD software and one of them was the automation process (Burić & Marjanović, 2018). As CAD software companies realizes the potential of Microsoft's Visual Basic, implementation of the programming language into their respective CAD software immediately take place to supply better solutions to engineers' or designers' past dilemma. In other words, the automation process feature in CAD spaces is not possible without Microsoft's Visual Basic programming language itself (Ćuković, Devedzic, & Ghionea, 2010).

An approach of using a product based on an existing design is one the examples of an automation task. Most industries will benefit a lot by implementing the approach as it increases the efficiency of design process which results in cost and time development reduction with controlled quality and fulfilling customer's different requests (Shafie, 2017). Within the CATIA modelling software, when combined with the ability of programming and macro tools enables the development of automation tasks. As the macro captures the scripts and commands of each line during the modelling process, the obtained script can be further coded into an interactive application which not only perform automation but also to produce a user-friendly interface which eases the user and program interaction.

In a nutshell, the latest technology of CAD automation and collaboration with programming languages with CAD software has not only resulted in better task in generating repetitive models, but also provides the ability to alter a complex design which may contain a tedious process, formulas, and equations. Instead of designing a model from scratch, a developed automation program with understandable user interface which only requires some user input could be benefit to less skilled workers and eases the need for skilled workers to constantly produce a quality product.

1.2 Problem Statement

In today's time, vehicle mass production has been rapidly increased as they become more widely available and affordable. It is not surprising that vehicle manufacturers today design their vehicle models roughly or similarly the same with other manufacturers especially manufacturers with partnership. Therefore, designers and engineers are constantly producing and making changes on existing designs to suit the market competition and customers satisfaction. This paper shows the capability of today's technology in automation of generating CAD models with the aid of coding by using the macros programming software in CATIA.

In mass production industry, development time is very crucial. With the aid of automation process, reduction time of development can be achieved which can be beneficial. When compared to conventional methods, automation process minimizes the chances of human error while maintaining the standard specification of the model data input.

As vehicles todays are roughly similar in design and shapes, some customers may desire some minor changes on certain parts of their vehicles. Since different customers have different design or taste they would prefer, it is a problem to the production process to fulfil

the demand of these customers. Therefore, the automation process helps to fill in this problem which eases the production of a customized product to each of their respective customer.

A shop which has the ability or skill in automation process can create a CAD model which will serve as the base of the model. With the base model, customers can customize the product itself with the consultation of the technician in charge or by entering the required parameters by themselves. The rising of online shopping among consumers also enables more opportunity for companies to provide a platform such as Shopee or Lazada for their customizable products or creating a dedicated online CAD platform for customers to freely design their own product and directly sends information into the company's database.

1.3 Research Objective

The objectives of this research project are:

a) To study the latest development of CAD automation

b) To develop the programming of automotive part using CATIA programming

c) To analyse the capability of CATIA programming in developing CAD automation

1.4 Scope of Research

The scope of this research are as follows:

- 3 types of bumper grille model with each of them having a different base pattern from each other using the CATIA software.
- Developing the program script coding through visual basic language which contained in macros tool
- Execution and assessment of the developed coding.

- Performing changes and fixes to the existing coding to suit the programming requirements.

CHAPTER 2

LITERATURE REVIEW

2.1 CAD (Computer Aided Design)

The term CAD or also known as Computer aided design refers to the usage of an electronic device for the purpose of assisting the user in creating a design. This includes performing simulations and analysis on a created virtual product or design for improvement. The main core of CAD system was its software which benefits the graphics for real time presentation (Shafie, 2017). The history of CAD can be traced back to 1963, which Ivan Sutherland developed a GUI-based Sketchpad for the purpose of generating x-y plots for his PhD thesis at MIT (Bi & Wang, 2020). The invention of CAD to manufacturing companies has led to reduction of costs and improvement of productivity involving repetitive works (Weisberg, 2008).

Early days of CAD were two dimensional which mostly were used in blueprints and aiding design drawings by hand. Further improvements and developments were carried on as the 3D-modelling capability of the CAD were proven useful in design sectors (Ball, 2013). This enables users to create and craft their product accordingly without the need of prototyping in early stages in design process. Animation and real-time simulation features such as static, dynamic, natural, heat transfer, plastic, fluid flow, motion, tolerance analysis and design optimization were also found in application of CAD (Shafie, 2017).

2.2 Automation

The word automation refers to the any applied technologies which minimizes human involvement in during a process. Benefits are better overall accuracy, precision and quality, lower material, and electrical costs. Automation increases efficiency of operation systems and decision-makers (Wang & Tan, 2006).

2.3 Automation Applications in CAD

Three types of automation are classified which are design, manufacturing, and administration automation (Shafie, 2017). Design automation refers to automated proposal documents, drawings or blueprints which involve the aid of any electronic devices. On the other hand, manufacturing automation refers to the automation of any machinery or mechanically driven operating system. In administration automation, it can be summarized as the automation process in managing data and information such as maintaining the student's information during admission process.

Application of automation in CAD expanded into various areas of development and production engineering process as years goes by due to its optimization process and its efficiency in terms of resources, costs, time, and quality improvement (Kreis, Hirz, & Rossbacher, 2020). Complexity of CAD models involves high number of parameters which directly affects memory, time consumption and graphics intensity for processing. When an incorrect parameter is entered along the way of development, it results in error which requires tracing back to the problem, hence, may increase development time. Therefore, automation process was introduced (S. & Suresh, 2015).