

INNOVATION AND DEVELOPMENT OF CAR'S WIPER SYSTEM

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SUPERVISOR'S DECLARATION

I have checked this report and the report can now be submitted to JK-PSM to be delivered back to supervisor and to the second examiner.

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LIST OF ABBEREVATIONS

DC	Direct Current
FE	Finite Element
3D	Three Dimensional
HOQ	House of Quality
APP	Application
FEA	Finite Element Analysis
CAD	Computer-aided Design
IDE	Integrated Development Environment
LED	Light Emitting Diode
PWD	Pulse Width Modulation
RXD	Receive Data
TXD	Transmit Data
COM	Communication port
COM3	Communication port 3
RPM	Revolution Per Minutes
DEG	Degree
PSM I	Projek Sarjana Muda 1
PSM II	Projek Sarjana Muda 2
ANSYS	Analysis System

LIST OF SYMBOL

β	=	Imbalance
Q	=	Time ratio
$\theta_3, \theta_4, \text{ and } \gamma$	=	Internal join angle
$L_1, L_2, L_3, \text{ and } L_4$	=	Length of Link
π	=	Pi
$\sqrt{\quad}$	=	Radical Sign
$^\circ$	=	Degrees
$\%$	=	Percentage
$*$	=	Asterisk Operator

ABSTRACT

This is an era of automation where it is broadly defined as the replacement of manual effort by mechanical power in all degrees of automation. Now a day's almost all automobile vehicles are being atomized to reduce human effort. The voice recognition wiper system is a full automation project. This is a genuine project designed for automobile vehicles and is fully equipped with a sensor circuit and wiper motor. This project aims to renew the existing car wiper system to a new or more effective one that can perform better than the previous one. The small design of the linkage that used only a single wiper arm gives benefits to a certain car such as a sports car which is can reduce the weight of the wiper. This project work includes the design and development of a wiper blade pattern to reduce noise and vibration during moving using Modal Analysis. Based on the result, unwanted noise and vibration was identified as one of the disturbances to wiper system and this show the effect of the natural frequency from other component not only from wiper blade.

ABSTRAK

Ini adalah era automasi di mana secara luas ditakrifkan sebagai penggantian usaha manual dengan kekuatan mekanik dalam semua tahap automasi. Kini hampir semua kenderaan automobil di atomisasi untuk mengurangkan usaha manusia. Sistem pengelap suara adalah projek automasi penuh. Ini adalah projek tulen yang direka untuk kenderaan kenderaan dan dilengkapi sepenuhnya dengan litar sensor dan motor pengelap. Projek ini bertujuan untuk memperbaharui sistem pengelap kenderaan yang ada kepada yang baru atau lebih berkesan yang dapat menunjukkan prestasi yang lebih baik daripada yang sebelumnya. Reka bentuk kecil jalinan yang hanya menggunakan lengan pengelap tunggal memberi manfaat kepada kereta tertentu seperti kereta sport yang dapat mengurangkan berat pengelap. Kerja projek ini merangkumi reka bentuk dan pengembangan corak bilah pengelap untuk mengurangkan bunyi dan getaran semasa bergerak menggunakan Analisis Modal. Berdasarkan hasilnya, bunyi dan getaran yang tidak diinginkan dikenal pasti sebagai salah satu gangguan pada sistem pengelap dan ini menunjukkan kesan frekuensi semula jadi dari komponen lain, bukan hanya dari pengelap.

CHAPTER 1

INTRODUCTION

1.0 Background Of Study

Nowadays, people life has been fully surrounded by the invention advance technologies that can help and be used in many function and industries. In terms of daily activities, people want a device that could be easy to be used for them to control or handle. "Innovation And Development Of Car Wiper System" is a project to renew the existing car wiper system to a new or more effective one which can perform better than previous one. The car wiper is a very important feature of a vehicle used to remove rainwater or other water from the vehicle windscreen. It's vital because it can make driving smooth in the rain and minimise road accidents and death.

Traditionally, the car's wiper used a manual instrument. The user needs to push the level switch control paddle on the steering wheel to move the wiper. All these manual instruments spend on wiper control could lead to road accidents because of the loss of the driver's attention. As time passed, a new scientific began to take place and affecting many aspects of daily human life. A lot of innovation and development of the car's wiper was starting to develop and be used to clean the windshield. As electricity and technology started to impact the industry and development, the advanced wiper system is being developed. There are many kinds of wiper system purposely to increase the performance of the wiper are being invented with different features by times. In this project, we design an automatic car's wiper system that is controlled by the Arduino. This design uses voice activation as a control system to control the movement of the wiper. Voice recognition can allow the driver to watch the road instead of using buttons or touch-screen icons. All the wiper's system has reduced the human touch as it requires less application of human effort and provide more comfortable driving and focus without any distraction.(P.Warke et al, 2019).

Next, the design of the new wiper blade's pattern will reduce the noise produce by the wiper while moving. It is very common for the windscreen wiper to produce excessive noise and vibration. This noise and vibration can be divided into three groups, including squeal noise, chattering and reversing noise. Squeal noise, also referred to as squeaky noise, is a high-frequency sound of around 1000 Hz. Chattering or beep noise is a low frequency sound of

100Hz or less. Reverse noise is an effect sound with a frequency of 500 Hz or less created when the wiper is reversed. This forms of noise and vibration contribute to visual and auditory discomfort with both drivers and passengers. With, various modification of the wiper blade pattern can reduce chatter vibration. (I.M Awang et al, 2009)

The coverage rate of wiped area is a critical index for designing the windshield wiper system and driver forward field of view in particular. When the wiped area is too small, it will cause to narrow the scope of vision, increase the risk of driving safety (H.Liang, 2019). The linkage of the wiper is compact, which is it requires a small box volume under the hood and easy to install, which makes it easier for to user to change itself at any time needed. This linkage design also increases the percentage coverage of the wiper to clean the windshield. Only one wiper's arm was used will reduce the cost of the maintenance to change the spare part after damage occurs. Thus, the project to be defined here is to improve the existing car's wiper to a new and more effective one that can perform better than the previous one by innovating, fabricating, and testing a system.

1.1 Problem Statement

Dim view of the driver is one of the factors for increasing the road accident for automobile transport as it can affect the driver's vision. The dim view occurs because of the percentage wiping coverage of the wiper on the windshield is to low. The driver required a higher percentage of wiping coverage of the wiper to increase the vision of the driver.

Generally, the manual instrument of car wiper requires a lot of human movement, which is the user has to push the level switch control paddle on the steering wheel. Referring to all the existing products of the car's wiper system, they use a switch control paddle to control the movement of the wiper. That will increase the risk of an accident to occur as it will interfere with attention to the driver.

It is very common for windscreen wipers to cause excessive noise and vibration. This noise and vibration can be categorised into three groups, namely squealing, chattering, and reversing noise (I.M Awang et al, 2009). These forms of noise and vibration contribute to visual and audible discomfort for both drivers and passengers.

For survey that has been done can be referred in appendix II. From the survey, the requirements of car wiper system are listed below:

1. The wiper must be able to clean 60% of the windshield's to improve the vision of the driver.

2. The wiper can operate automatically by using voice recognition.
3. The design of the wiper blade pattern must reduce the noise and vibration produce during sweeping.

The project will cover these requirements, which are elaborated in depth in this report, in attempt to develop a working conceptual design.

1.2 Objective

When designing a product, it's good to line up some aims and objectives which can be guiding you and that they will offer you a summary of what you're getting ready to do. These aims and objectives are later analyzed after the finalizing of the work to determine whether or not they were met.

These aims and objectives are:

1. To design a linkage system that using single wiper arm which is better than existing car that using two wiper arm.
2. To upgrade wiper control from manual switch control paddle to voice recognition.
3. To study and analyze the wiper blade pattern, which is can reduce the noise and vibration of the wiper.

1.3 Scope Of Project

The scope of the project that has been used to complete this project is explained as below:

1. Study how to combine the circuit for sensor, controller and motor.
2. This design uses the existing component of the wiper arm and does not involve the washer system.
3. Modelling in Catia v5 R21 for components.
4. The study of wiper blade pattern using FEA simulations (Modal Analysis) that define what the natural frequencies of the wiper blade pattern are.
5. This design does not produce real prototyping of the new blade pattern design due to the limitation of the machine.
6. The design of the linkage using Working Model 2D.
7. All the result for both simulation and analytical is needed to compare.

1.4 General Methodology

Project planning is the most important phase, which is to develop the car wiper system. During this phase, it's started with the title definition to know what's the most element should be meted out. In this project, the methodology then initiates with broad information gathering a thorough survey to determine the limitations of this study and priorities that will later determine the specification of demand. From the demand specification and the gathered knowledge, concepts are developed with support from product development tools and methods. The concepts are then developed and evaluated, which leads to one final concept for further development. To assure the quality of the result, product development utilizes proven methodologies and tools. The following chapter describes the used methodology, development process, and tools utilized to support and assure the quality of the project.

1.4.1 Product Development Process

There are several different ways to manage the development of products. In certain instances, it is useful to use a proven, reliable product development method to effectively execute the project. The method of product design in this project is an adapted version of the development process of Ulrich and Eppinger's in the book Product Design and Development (Ulrich & Eppinger, 2008)

1.4.2 Ulrich And Eppinger's Development Process

Figure 1.1 proposed six steps process by Ulrich and Eppinger (2008).The strategy describes a method starting with planning and ending with production ramp-up.



Figure 1.1 - Production development process(Ulrich & Eppinger,2008).

1.4.3 Adapted Production Development Process

Since the goal of the project is often the concept,many of the phase,such as production and ramp-up do not seem to be important,an adapted development process has been introduced through the project.The researched focus on a pre-study to define at the problem formulation

of the project and to investigate new approaches, alternative to the matter, and to establish a strategy based on these result. As a result, this initiative was split into three phases. Each phase covers different steps of the strategy and includes general methods and products development tools which strive to secure qualitative result. As seen in Figure 1.2, the last phase includes the last development, and the design should be finalised after the phase.

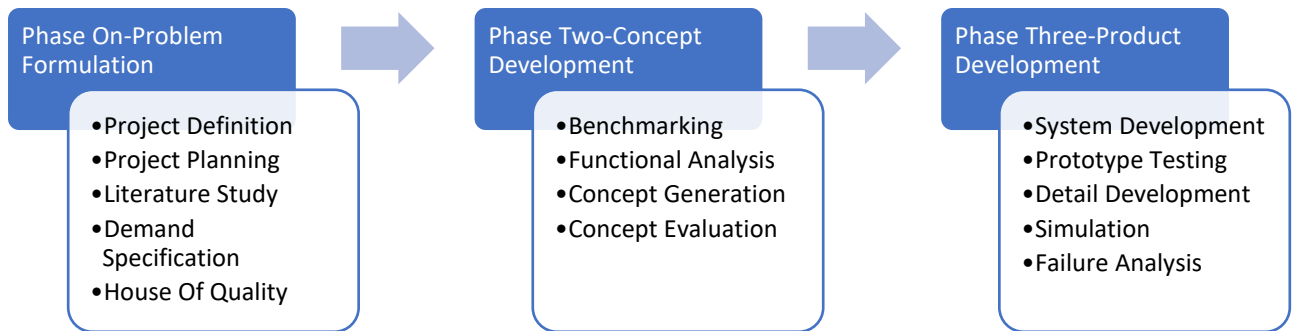


Figure 1.2 - Adapted Product Development process(Ulrich & Eppinger,2008).

1.4.4 Tools

A variety of tools and approaches have been used in the project to help and secure a scientific methodology. The methods used and their implementation are listed below.

i. Catia v5 r21

Catia V5 R21 is a multi-platform software developed by the French company Dassault System and being used for constructing and assembling the product. In addition, the programme is being designed to produce drawings for manufacturing (Dassault Systems, 2015).

ii. Working model 2d

Working Model 2D is generated and distributed by Design Simulation Technologies and is used to construct a desktop computer model that represents a mechanical devices and perform dynamic analysis. This section uses the Working Model to construct a four bar linkage model and run a simulation.

iii. Ansys 16.0

Ansys Software is a global public company based in Canonsburg, Pennsylvania and being used to study the natural frequency of the wiper blade pattern (Modal Analysis). Several

type of wiper blade pattern has been proposed and being analysed using Ansys to identify the lowest natural frequency produced during sweeping by the wiper.

1.4.5 Product Development Method And Tools

The approach for the adapted product creation process used in this project as seen in Figure 1.2.

The first phase, problem formulation aims to collect the maximum amount of relevant information from primary and secondary sources as much as possible, in order to obtain a large base of data to be used within the project.

Project Planning-Gantt-schedule

Planning is the secret to the successful execution of the project. Due to the limitation of time during this project, the Gantt-Schedule was used to organise and divide the time between all the required activities. The Gantt Schedule can be found in Appendix 1.

Pre-Study

The initial pre-study was considered important for the project, where the purpose was to understand and identify the objective and the definition of the project. The current solutions for the windshield and wiper system were therefore studied both in parts and in action. The wiper mechanism and its elements could be quickly studied in CAD-programs and drawings, where geometry, form and assembly were studied.

Literature review

A literature review needs to be carried out in order to improve comprehension. The review will also provide a strong framework for the project, as it will assist with the methodology and approaches supported by previous writings.

House Of Quality(HOQ)

The House of Quality (HOQ) is characterised as a product planning matrix that is designed to show how customer requirements relate directly to the ways and methods that companies can use to meet those requirements.

The second phase of concept development is aimed to use the information from the first phase in idea and concept generation tools.

Benchmarking

According to Ulrich and Eppinger(2008), the first step in the broad concept development phase is to consider competitive products. Benchmarking is also used to compare solutions and functions in the same product category as well as ideas and functions in other market segments. A different solution was tested in order to find the advantages and disadvantages to be included in the concept.

Function Analysis

The morphological chart is a method to generate ideas analytically and systematically. The desired features or functions are defined according to the product. Various functions of the product may be used, and different designs are used to represent the function. It's a visual aid used to come up with a variety of ideas. A table can also be compared on the basis of a function analysis where the created idea is visualised in a morphological map. Besides, all the possible ideas generated from each individual can also include the table. It is recommended to create multiple designs or features for each function of each concept. Each concept varies in terms of geometry, physical and material. Therefore, there are a few design concepts are illustrating from the combination of function. The first column of the morphological chart shows a column for multiple functions which is a list of function for our designed product to be developed. While in the row of the table, it shows the different type of choice to be chosen in developing a concept design. Each row shows a variety of different design for each function listed.

Concept generating

One technique used to generate new ideas or solutions is brainstorming. The method can be used by both groups and individuals, and according to Ulrich & Eppinger(2008), four criteria that are useful for enhancing the search are as follows:

- i. Suspend judgment
- ii. Generate a lot of ideas
- iii. Welcome ideas that may seem infeasible
- iv. Use graphical and physical media

Concept Evaluation

The concept evaluations in the product development process are important in that the concepts are tested against each other and the product specifications. There are many different approaches and techniques available to test and eliminate the concept. One concept used to evaluate difference concept each other is Pugh's matrix.

In the final phase, which focuses on product development, the final concept is chosen to concentrate the development process on system and detail development of the affected components. The processes and methods used in phase three are discussed below.

System and detail development

The aim of the system development is to define major subsystems and interfaces and to refine the industrial design of the product (Ulrich & Eppinger, 2008). The development of the system is followed by a detailed design and development aiming at identifying the geometry, material and tolerance components (Ulrich & Eppinger, 2008)

Failure analysis

Possible risks and failures that may happen for a product may be analyzed by a Failure Mode and Effects Analysis (FMEA) to scientifically test the product. The risk analysis tool analyses the various potential failures that can occur for the product and the results that they produce. The analysis results in recommended actions for all possible failures to minimize or eliminate the failures (Ulrich & Eppinger, 2008).

Prototype

A physical prototype allows testing and experimentation, which gives the development a possibility for deeper learning and if the product works (Ulrich & Eppinger, 2008). To test the function and effects of the proposed conceptual solution during different circumstances, it was deemed suitable to manufacture a functional prototype in this project. The methodology of this study is summarized in the flow chart as shown in Figure 3.2.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will study the crank rocker mechanism, noise produce by wiper blade and function of the control system components.

2.1 Car Wiper System



Figure 2.1: Car wiper

It's part of the basic stuff that all cars can have. It is essential to ensure that drivers have a clear and unobstructed view of the road. Figure 2.1 displays the example traditional car wipers commonly used today.

2.1.1 History of car wiper system

The history of the windshield wiper started with the invention of the car. Most of the transport vehicles did not have wipers. Horse-drawn carriages and trucks traveled at slow speeds, and there was no need for glass to shield the driver or passengers or to serve as a windbreak. The first wipers in the windshield were the brushes. Inventor J. H. Apjohn came up with a way of sliding two brushes up and down on a vertical glass windshield plate in 1903. In the same year, Mary Anderson devised a swinging arm that swept rain out of the window as the driver pulled a lever inside the car. Anderson patented the invention of a mechanical windshield wiper in 1905 and became a standard commodity in 1913. Electric motors have not

yet been used to power car necessities or accessories, and Anderson's device has had a downside. Without another power source, the driver needed to use one hand to shift the trigger. The other hand of the driver steered the vehicle (with either a wheel or a steering wheel) and operated the stick-mounted gear shift and the brake grips on the car floor or outside the driver's side on the running board. (Brachmann, 2014)

Rubber strips replaced brushes as wiper cleaning equipment in 1905. Unfortunately, the risky need for drivers to clean out windshields while driving was not removed until 1917. The alternative was to use an electric motor to drive a single wiper with a long rubber blade back and forth. Hawaiian dentist Dr. Ormand Wall invented an automatic wiper by installing an electric motor in the top center of the windshield so that the wiper washed over the car hood in a semi-circular or rainbow shape. Wipers were one of the first electronic instruments in cars since the electric starter was built in 1912. Most of the car wipers were combined and hanging from the top of the windshield before 1930. They moved to the base of the windshield as electrical systems got more complex. Windshield washers were attached to the wiper on/off levers and this needed spray nozzles in front of the windshield, a washer fluid tank in the engine compartment, and electrical connections to coordinate these operations. (Rain Eater Wiper Blades, n.d.)

In 1962, Bob Kearns invented the intermittent wiper at times and speeds that could be adjusted by the driver. The introduction of electronic devices with fuses and circuit breakers to work, control, and organize electrical components has extended the possibilities for a broader variety of wipers. Wipers were introduced to the headlights in the 1980s, involving interfaces between the lighting systems and the wiper systems. In the 1990s, microsensors were mounted in windshields to sense rain on the windshield, to enable the wipers, and to change the speed and occasional usage for the volume of rain. (Windscreen wiper, n.d.)

2.1.2 Type of Car Wipers

By contrast, most of today's cars are powered by electric car wipers. Drivers can also control the speed of the wiper depending on the weather conditions. The first window cleaner was operated by manually pressing the lever back and forth to the inside of the car. Types of wipers used by car manufacturers to match the vision of the driver are shown in Figure 2.2. The single-arm wiper can provide greater overall coverage but is more complex than the widely used two blade systems (Tandem system).

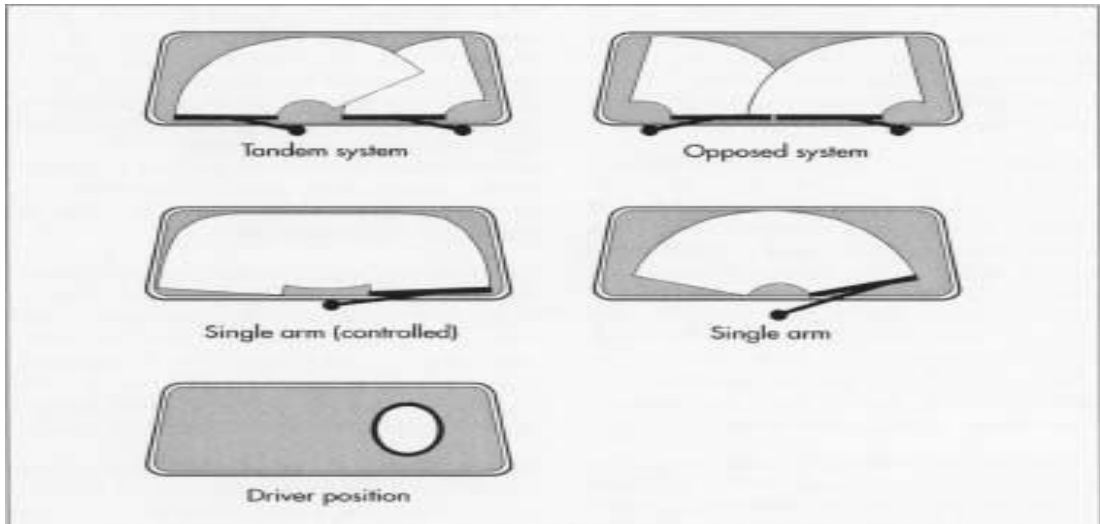


Figure 2.2 : Several type of wiping system(D Gowtham,2014)

2.1.3. Car Wipers Operating Principles

Usually, conventional car wipers today are typically made up of combinations of two mechanical technologies:

- i. A combination of electric motor and worm gear reduction, which gives power to the wipers.

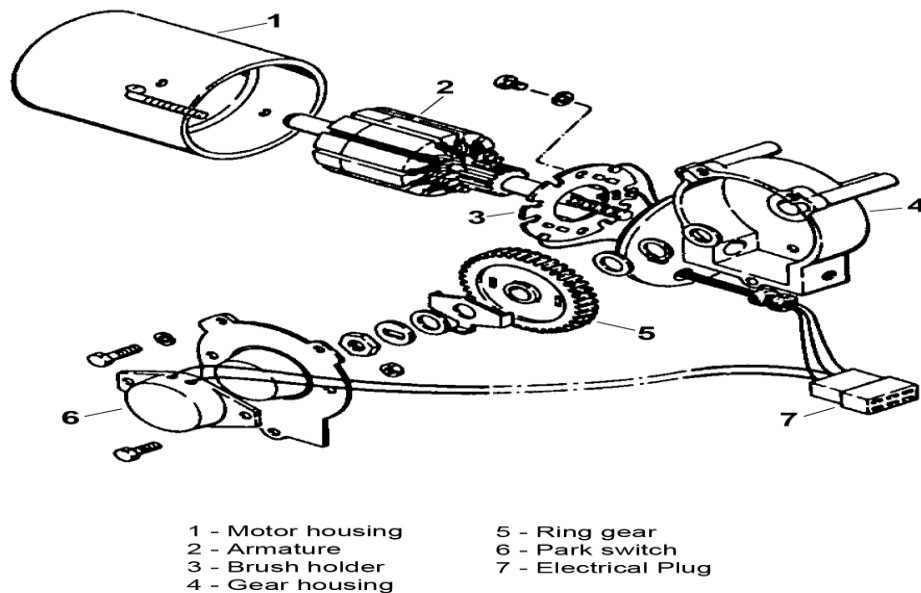


Figure 2.3: Motor and Gear Reduction (Derek Garnier, n.d.)

Figure 2.3 shows the motor and gear reduction for wiper motor. To quickly generate the motion of the wiper arm back and forth, there is a lot of force to be generated. To achieve the desired power, a worm gear is used on the output of a motor. A worm gear reduction would increase the torque of the engine by approximately 50 times, while at the same time slowing the output speed of the electric motor by 50 times.

- ii. A neat linkage that applies the rotary output of the motor to the back-and-forth motion of the wipers.

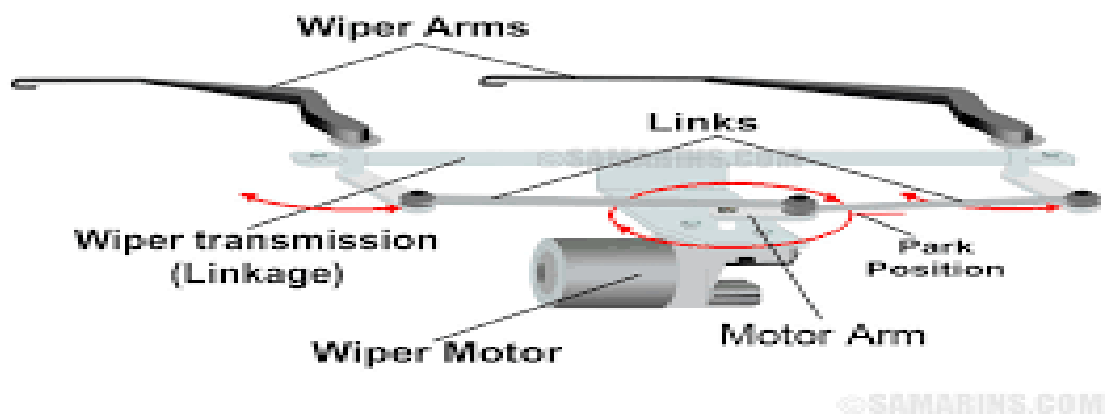


Figure 2.4: Linkage connection of car wiper (SAMARINS.COM, November 29,2018)

Figure 2.4 show the linkage connection of car wiper. The short cam is attached to the gear-reduction output shaft. As the wiper motor spins, the cam is turning. A long link is attached to the cam; it drives the link back and forth as the cam is spinning. A short link acting on the driver's side of the wiper blade is attached to the long link. The force from the driver-side to the passenger-side wiper blade is transferred via another long link.

2.1.4 Design of the Wiper Blades

To clear the water, a thin rubber strip film drags the wiper arms over the windshield. The efficiency of the wiper blades to properly clean the windshield glass is attributed to several factors:

- i. The slope and the windshield area
- ii. The amount of spring tension on the wiper arm
- iii. The blade material