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ANALYSIS OF THE RELIABILITY OF POWER WINDOW SYSTEM FOR SEDAN CARS

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This report is proposed to fulfill some of the requirements to be honored with Bachelor of Mechanical Engineering (Design and Innovation)

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“I verify that this report is my own work except for the citation and quotation that the source had been clarify for each of the”

Signature :…………………..

Author : …………………..

Date : …………………..

To my beloved family for their encouragement and support especially, and for their understanding in the way I am.

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ABSTRACT

The purpose of this work is to study and analyze the reliability if the power window system for sedan cars through statistical analysis. The manufacturer of the car that had been chosen was Proton and the model of the car is Proton Waja. The failure data for the system will be gathered from the service centre and public survey for analysis using Weibull Distribution method. The difference in data that had been gathered will be further analyzed using Statistical Analysis to verify the average lifespan of the system. With the analysis, the reliability of the system can be determined. All of the causes of the failure will be discussed.

ABSTRAK

Tujuan kajian ini dijalankan adalah untuk mengkaji dan menganalisis keboleharapan untuk sistem tetingkap kuasa kereta jenis sedan melalui kaedah statistik. Pengeluar kereta yang telah dipilih dalam kajian ini adalah Proton manakala model bagi keretanya adalah Proton Waja. Data-data untuk kegagalan sistem berkenaan diperoleh dari pusat-pusat servis serta soal selidik para pengguna yang mana akan dianalisis menggunakan kaedah Taburan Weibull. Perbezaan antara data-data yang diperoleh akan dikaji secara lebih mendalam menggunakan Kajian Statistik bagi mendapatkan kadar purata untuk jangka hayat sistem berkenaan. Berdasarkan analisa yang dilakukan, keboleharapan bagi sistem tetingkap kuasa ini dapat ditentukan. Semua punca kegagalan akan dikaji.

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LIST OF SYMBOLS

BIL	ITEM
MBTF	Mean time before failure
MTTF	Mean time to failure
CFR	constant failure rate (matured phase)
IFR	increasing failure rate (chronic failure)
DFR	decreasing failure rate
R(t)	reliability
F(t)	non-reliability
$\lambda(t)$	hazard rate
σ	standard deviation
σ^2	variance
β	shape parameter
θ	characteristic life
Γ	Gamma fucntion
t	time
ANOVA	Analysis of Variance

CHAPTER 1

INTRODUCTION

1.1 Background

Power windows, also known as electric windows are automobile windows which can be raised and lowered by depressing a button or switch, as opposed to using the old style, hand-turned crank handle. The switch is usually being placed in the driver's side door. However, in typical installation, there is an individual switch at each window and a set of switches in the driver's door, so that the driver can operate all the windows easily.

The system is usually operates when the car is running as the electrical system is off, or not 'live' once the ignition has been turned off. However, certain manufacturers had developed time delay feature, and being installed in many modern cars, called retained accessory power. This feature allows the power window and some other electronic accessories operate normally for some period of time after the car's engine stopped.

Although the system is a good feature to replace the old style hand-turned crank handle, it might not be so friendly to kids. There are a lot of reports of accidents which relate to the system, usually kid's necks being trapped, leading to suffocation. Some manufacturers innovate the system, as they set a driver-controlled lockout switch to prevent kids accidentally triggering the switches.

1.2 Objective

The purposes of the project are decided by the beginning of the project. They are as follows:

i. Analyze the reliability of the power window system for sedan cars
ii. Decide the life time of the power window system based on analysis of the data

1.3 Scope

The scopes of the project are as follows:

i. To study the failure data for the system
ii. To analyze the data using statistical method and come out with reliability of the system as the output
iii. To decide the life time of the system

1.4 Problem Statement

In the automotive industries, power window system is a good feature to be installed in today modern cars as it gives luxurious feeling to the owner. The system should have expiring date as stated in the warranty. However, many of the systems failed to operate before the date due to some problems such as power window system failure. This phenomena gives a bad impression from the users against the automotive manufacturers. The situation also questioned the users about how far of the reliability of the system can be trusted.

CHAPTER 2

LITERATURE REVIEW

2.1 Hand-turned Crank Handle

A crank is an arm at right angles to a shaft, by which motion is imparted to or received from the shaft. It is also used to change circular into reciprocating motion, or reciprocating in to circular motion. The arm may be a bent portion of the shaft, or a separate arm keyed to it.

One application is human-powered turning of the axle. Often there is a bar perpendicular to the other end of the arm, often with a freely rotatable on it to hold in the hand, or in the case of operation by a foot; usually with a second arm for the other foot, with a freely rotatable pedal.

Applications for crank are as below:

I. Using a hand
   i. Mechanical pencil sharpener
   ii. Fishing reel and other reels for cables, wires ropes, etc.
   iii. Train window
   iv. Manually operated car window
II. Using feet
   i. The crank set that drives a bicycle via the pedals
   ii. Treadle sewing machine

2.1.1 Manually Operated Car Window

Figure 2.1: Hand-crank car window

(Source: http://en.wikipedia.org/wiki/Crank)

The hand-crank car window is a mechanism which uses a crank and manpower to run the system. The mechanism is simple, which build up with a crank, gears and shaft for the system. Human power is needed to run the mechanism in circular motion, by turning the crank counter-clockwise for opening the window and vice-versa.

2.1.2 Manual Regulator Window

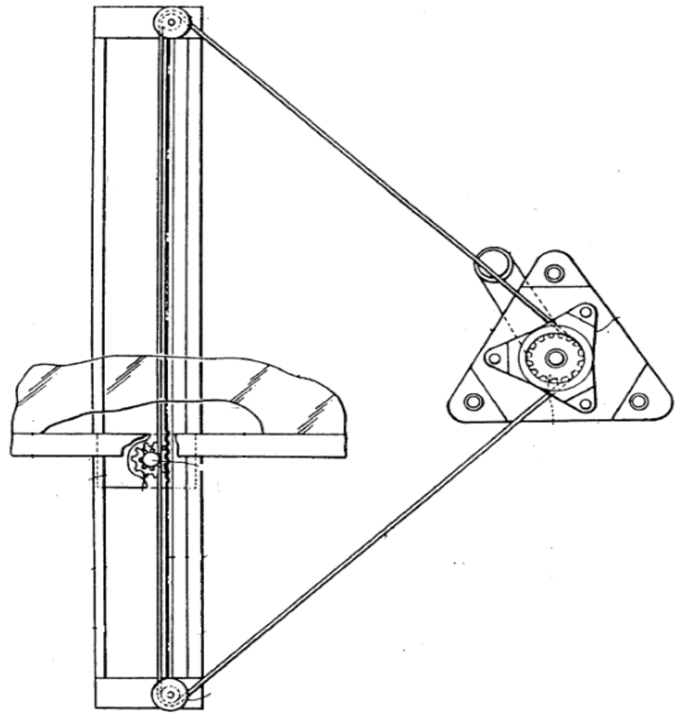

Figure 2.2: Manual window regulator

A manual window regulator in which a pinion rotatable carried by a window glass and driven by a manual handle is held in engagement with a rack which is fixed to extend in the direction of movement of the window glass, so that a manual rotation of the handle causes the pinion to roll along the rack in meshing engagement therewith so as to drive the window glass thereby opening and closing the window. The transmission of rotation from the handle to the pinion is effected through a tape stretched between a driver gear rotationally driven by the handle and driven gear coaxially fixed to the pinion. The rack and the pinion are usable also as the parts of a power window regulator. The manual window regulator therefore can be easily converted into a power window regulator by using an electric motor for driving pinion in place of the unit including the handle, the drive gear and the tape.

(Source:http://www.google.com/patents?id=BJMdAAAAEBAJ&dq=manual+window+regulator)

2.2 Power Window

As explained early in introduction section, power windows are electronic automotive windows which can be controlled, raised and lowered by a switch or button. The system is a feature that replaced the old style hand-turned crank handle.

A power window system should be build of:

i. Electric motor
ii. Switches and wiring
iii. Lifting mechanism

2.2.1 Electric Motor

Figure 2.3: An electric motor

(Source: http://en.wikipedia.org/wiki/Electric_motor)

An electric motor uses electrical energy to produce mechanical energy. The reverse process, that of using mechanical energy to produce electrical energy, is accomplished by a generator or dynamo. Traction motors used on locomotives and some electric and hybrid automobiles often perform both tasks if the vehicle is equipped with dynamic brakes. Electric motors are found in household appliances such as fans, refrigerators, washing machines, pool pumps, floor vacuums, and fan-forced ovens.

Type	Advantages	Disadvantages	Typical Application	Typical Drive
AC Induction (shaded pole)	Least expensive Long life High power	Rotation slips from frequency Low starting torque	Fans	Uni/Poly-phase AC
AC Induction (split-phase capacitor)	High power High starting torque	Rotation slips from frequency	Appliances	Uni/Poly-phase AC
AC Synchronous	Rotation in-sync with frequency Long life (alternator)	More expensive	Clocks Audio turntables Tape drives	Uni/Poly-phase AC
Stepper DC	Precision positioning High holding torque	Slow speed Requires a controller	Positioning in printers and floppy drives	Multiphase DC
Brushless DC electric motor	Long lifespan Low maintenance High efficiency	High initial cost Requires a controller	Hard drives CD/DVD players Electric vehicles	Multiphase DC
Brushed DC electric motor	Low initial cost Simple speed control (dynamo)	High maintenance (brushes) Low lifespan	Treadmill exercisers Automotive starters	Direct (PWM)

Table 2.1: Comparison of motor types

(Source: Motor Comparison, Circuit Cellar Magazine, July 2008, Issue 216, Bachiochi, p.78)

A simple motor has six parts, as shown in the diagram below:

- Armature or rotor
- Commutator
- Brushes
- Axle
- Field magnet
- DC power supply of some sort

An electric motor is all about magnets and magnetism: A motor uses magnets to create motion. If you have ever played with magnets you know about the fundamental law of all magnets: Opposites attract and likes repel. So if you have two bar magnets with their ends marked "north" and "south," then the north end of one magnet will attract the south end of the other. On the other hand, the north end of one magnet will repel the north end of the other (and similarly, south will repel south). Inside an electric motor, these attracting and repelling forces create rotational motion.

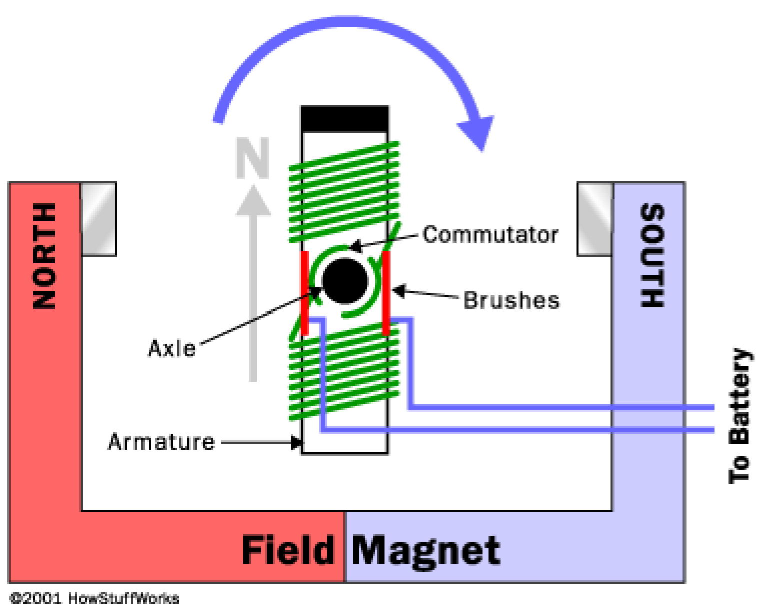

Figure 2.4: Parts of an electric motor

(Source: http://en.wikipedia.org/wiki/Electric_motor)

The armature (or rotor) is an electromagnet, while the field magnet is a permanent magnet (the field magnet could be an electromagnet as well, but in most small motors it isn't in order to save power).

The electric motor can be divided into two types:

i. Direct current (DC)
ii. Alternating current (AC)

Considering all rotating or linear electric motors require synchronism between a moving magnetic field and a moving current sheet for average torque production, there is a clearer distinction between an asynchronous motor and synchronous types. An asynchronous motor requires slip between the moving magnetic field and a winding set to induce current in the winding set by mutual inductance; the most ubiquitous example being the common AC induction motor which must slip in order to generate torque. In the synchronous types, induction is not a requisite for magnetic field or current production.

2.2.2 Switches and Wiring

Car doors are wired in many different ways, depending on which features are incorporated. We'll go through the wiring on a basic system -- one that allows the driver to control all four windows on the car and can lockout the controls on the other three individual windows.

Figure 2.5: Various types of switches

(Source: http://en.wikipedia.org/wiki/Car_switch)