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 (Automotive)"

Signature : ....

Supervisor I : En. Herdy Rusnandi.

Date : ....

Signature : ....

Supervisor II : ………………………..

Date : ....

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: Amir Farhan Bin Maarof

Date: ....

To my lovely parent,

To my brothers and sister.

To whom I owe my spirit and dream.

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ABSTRACT

Objective of this project is to design and develop car door lock actuator using shape memory alloy (SMA) material. Conventional car door lock actuator using motor to actuate the actuator. Several design of SMA actuator has drawn and one best design is choose to be develope as prototype. Design considerations state at the beginning of the project and the design must follow the parameters. Then, every design will be discuss to choose the best while mark will be given. The highest will be the best design. In this project, the shape memory alloy (SMA) is a group of materials which have the ability to return to a predetermined shape when heated. Due to this special behavior, the shape memory alloy has a wide variety of practical applications such as actuator due to its unique super-lasticity and shape memory effect. The design is drawn by using CATIA CAD Software begin with sketch in plain paper to determine it parameter. Conclusion of this project is the shape memory alloy (SMA) can be use as new car door lock actuator replace the conventional car door lock actuator using motor.

ABSTRAK

Tujuan projek ini adalah untuk membangunkan aktuator untuk kunci pintu kereta dengan menggunakan bahan “Shape Memory Alloy (SMA)”. Kebiasaannya, kunci pintu kereta menggunakan motor sebagai penggerak utama actuator. Beberapa rekabentuk SMA actuator telah dilukis dan rekaan terbaik telah dipilih untuk diuji sebagai prototaip. Pertimbangan rekabentuk haruslah dusenaraikan dan rekaan mestilah mengikut parameter yang telah disenaraikan. Kemudian, setiap rekabentuk dibincang untuk memilih rekaan terbaik berpandukan markah skor yang telah diberi. Skor tertinggi dipilih menjadi rekaan terbaik. Dalam projek ini, SMA adalah sekumpulan bahan yang memiliki kemampuan untuk kembali ke bentuk yang telah ditentukan bila dipanaskan. Kerana perilaku khas ini, SMA mempunyai pelbagai aplikasi practikal seperti aktuator kerana keunikkan “super-lasticity” dan kesan “shape memory”nya. Rekaan telah dilukis dengan bantuan perisian lukisan berbantu komputer iaitu “CATIA” dimulakan dengan lakaran di atas kertas kosong untuk menentukan parameter. Kesimpulannya, SMA boleh digunakan sebagai aktuator kunci pintu kereta yang baru menggantikan aktuator kunci pintu kereta yang kebiasaannya menggunakan motor.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT INTRODUCTION

Nowadays, everyone is talking about advances technology and exploration about making new product development for the future use. Technology cannot run from human life which is making our life easier.

An actuator is something that converts energy into motion. It can also be used to apply a force. An actuator typically is a mechanical device that takes energy, usually created by air, electricity, or liquid and converts that into some kind of motion. That motion can be anything from blocking to clamping to ejecting. Actuators are typically used in manufacturing or industrial applications and may be used in things like motor, pumps, switches and valves.

Commonly, car door locking system functions to prevent the door for being opened. Conventional car door lock system consists of motor as actuator, connecting rod, latch and electrical part. The motor moved the actuator up and down to unlock and lock the door. The lock may be actuated to lock the door and prevent unlatching the door.

Shape Memory Alloy (SMA) has been study for use as new actuator. Shape memory alloy have proven their worth in solving engineering problems that in the past seem implausible. Only a few decades old, this new breed of driving mechanism has a bright future ahead since shape memory elements provide a significant amount of actuation with an extremely small envelope volume. This statement becomes truer and their implementation even more important when looking at the direction where technology is heading. In the modern world great emphasis has been placed in miniaturization. Micro devices are being developed and implemented today to perform a multiple of tasks with nano technology following very closely behind.

However, shape memory alloys are not for all applications, it can be used for limited applications such as robotics, biomechanics, surgery, transportation vehicles, computer components and space components. One must take into account the forces, displacements, temperature conditions and cycle rates required of a particular actuator. So far though, mainly because of efficiency concerns, shape memory alloys have yet be adopted fully in large-scale applications. Albeit that they do have a tough competition with hydraulics, electrical motors and internal combustion engines to go against them, there are large-scale applications that would benefit from their use, especially when size is a major design factor to consider.

1.2 OBJECTIVE

The objective of this project is to design and develop car door lock actuator using shape memory alloy material.

1.3 SCOPE

The title of this project is development of car door lock actuator using shape memory alloy (SMA) material. Therefore, the scope of this project related to:

1. To study mechanical behaviour of shape memory alloy (SMA) for actuator application.
2. To design and develop a prototype of car door lock actuator using shape memory alloy (SMA) material.
3. To study the performance of the prototype.

1.4 PROBLEM STATEMENT

Nowadays, conventional car door lock using motor as actuator. The actuator by using motor was designed with complicated gears. From that consideration, this project is to change the conventional car door lock actuator using shape memory alloy material. There have problems and questions during design and choose the better design suitable to conventional car door lock actuator mechanism.

Commonly, conventional car door lock using motor as actuator. It moves up and down to unlock and lock the door. It also can be moves mechanically by our hand. Usually, we used electric current supply to actuate the actuator. The actuator consists of motor and gear so that it moved due to the rotation of the motor. For example, when we want to lock the door, the motor rotate so that the gears follow the rotation and the door lock move down. The rotations of motor have a limit till the door lock fully locked and so on when unlock the door.

Shape memory alloy actuator consists of SMA wire or SMA spring as the main part. It is functions by heat or electric heat generated. The shape memory alloy materials can deform to any shape and return to its original shape when heat or electric applied. From this special behavior of shape memory alloy material, we try to design and change motor to SMA as car door lock actuator.

The main barrier is to choose suitable shape memory alloy actuator with their related mechanism to car door lock actuator application. The conventional car door locks actuator specifications which are operating force, working force and operating current. From this specifications, the suitable shape memory alloy actuator is select relate to the conventional car door lock specifications.

CHAPTER 2

LITERATURE REVIEW

2.1 WHAT IS AN ACTUATOR?

An actuator is a mechanical device for moving or controlling a mechanism or system. It is operated by a source of energy, usually in the form of an electric current or hydraulic fluid pressure, and converts that into some kind of motion.

An actuator is something that converts energy into motion. It can also be used to apply force. An actuator typically is a mechanical device that takes energy, usually created by air, electricity, or liquid, and converts that into some kind of motion. That motion can be anything from blocking to clamping to ejecting. Actuators are typically used in manufacturing or industrial applications and may be used in things like motors, pumps, switches, and valves.

Perhaps the most common type of actuator is powered by air, the pneumatic cylinder, also known as the air cylinder. Air cylinders are air-tight cylinders, typically made from metal, that use the energy of compressed air to move a piston. Air cylinders are most commonly used in manufacturing and assembly processes. Grippers, which are used in robotics, use actuators driven by compressed air to work much like human fingers.

Actuators can also be powered by electricity or hydraulics. Much like there are air cylinders, there are also electric cylinders and hydraulic cylinders where the cylinder converts electricity or hydraulics into motion. Hydraulic cylinders are often used in certain types of vehicles. Many actuators have more than one type of power source. Solenoid valves, for example, can be powered by air *and* electricity. Electricity powers the solenoid, and the solenoid, powered by air, actuates the valve. Alternatively, the solenoid can be powered by hydraulics and electricity.

Actuators can create a linear motion, rotary motion, or oscillatory motion. That is, they can create motion in one direction, in a circular motion, or in opposite directions at regular intervals. Hydraulic and air cylinders can be classified as single acting, meaning that the energy source causes movement in one direction and a spring is used for the other direction. Alternatively, these cylinders can be double acting cylinders, meaning the energy is used in two directions.

2.2 CAR DOOR LOCK MECHANISM

The mechanism that unlocks your car doors is actually quite interesting. It has to be very reliable because it is going to unlock your doors tens of thousands of times over the life of your car. Here are some of the ways that you can unlock car doors:

1. With a key.
2. By pressing the unlock button inside the car.
3. By using the combination lock on the outside of the door.
4. By pulling up the knob on the inside of the door.
5. With a keyless-entry remote control.
6. By a signal from a control center.

In some cars that have power door locks, the lock/unlock switch actually sends power to the actuators that unlock the door. But in more complicated systems that have several ways to lock and unlock the doors, the control system decides when to do the unlocking.

The control system is a computer in your car. It takes care of a lot of the little things that make your car friendlier. For instance, it makes sure the interior lights stay on until you start the car, and it beeps at you if you leave your headlights on or leave the keys in the ignition.

In the case of power door locks, the body controller monitors all of the possible sources of an "unlock" or "lock" signal. It monitors a door-mounted touchpad and unlocks the doors when the correct code is entered. It monitors a radio frequency and unlocks the doors when it receives the correct digital code from the radio transmitter in your key fob, and also monitors the switches inside the car. When it receives a signal from any of these sources, it provides power to the actuator that unlocks or locks the doors.

2.2.1 Inside a car door

In this car, the power-door-lock actuator is positioned below the latch. A rod connects the actuator to the latch, and another rod connects the latch to the knob that sticks up out of the top of the door.

Figure 2.1: A car door lock

(Source: www.howstuffworks.com)

When the actuator moves the latch up, it connects the outside door handle to the opening mechanism. When the latch is down, the outside door handle is disconnected from the mechanism so that it cannot be opened. To unlock the door, the body controller supplies power to the door-lock actuator for a timed interval.

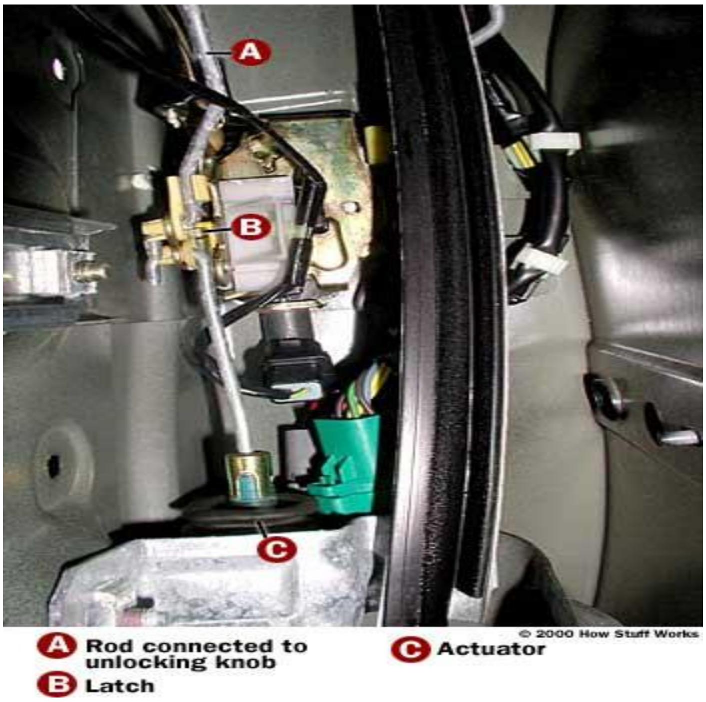

Figure 2.2: Inside a car door

(Source: www.howstuffworks.com)

2.2.2 Inside the actuator

The power-door-lock actuator is a pretty straightforward device. This system is quite simple. A small electric motor turns a series of spur gears that serve as a gear reduction. The last gear drives a rack-and-pinion gearset that is connected to the actuator rod. The rack converts the rotational motion of the motor into the linear motion needed to move the lock.

Figure 2.3: Car door lock actuator

(Source: www.howstuffworks.com)

This actuator can move the metal hook shown in this photo to the left or right. When mounted in the car, it is vertical, so the hook can move up or down. It mimics your motions when you pull the knob up or push it down.

Figure 2.4: Inside the door lock actuator

(Source: www.howstuffworks.com)

One interesting thing about this mechanism is that while the motor can turn the gears and move the latch, if you move the latch it will not turn the motor. This is accomplished by a neat centrifugal clutch that is connected to the gear and engaged by the motor.

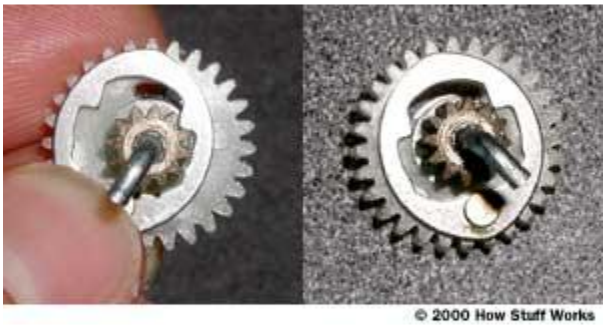

Figure 2.5: Centrifugal clutch on the drive gear

(Source: www.howstuffworks.com)

When the motor spins the gear, the clutch swings out and **locks** the small metal gear to the larger plastic gear, allowing the motor to drive the door latch. If you move the door latch yourself, all of the gears will turn except for the plastic gear with the clutch on it.

2.3 INTRODUCTION TO SHAPE MEMORY ALLOY

Shape Memory Alloys (SMA's) are novel materials which have the ability to return to a predetermined shape when heated. When an SMA is cold, or below its transformation temperature, it has a very low yield strength and can be deformed quite easily into any new shape, which it will retain. However, when the material is heated above its transformation temperature it undergoes a change in crystal structure which causes it to return to its original shape. If the SMA encounters any resistance during this transformation, it can generate extremely large forces. This phenomenon provides a unique mechanism for remote actuation.

The most common shape memory material is an alloy of nickel and titanium called Nitinol. This particular alloy has very good electrical and mechanical properties, long fatigue life, and high corrosion resistance. As an actuator, it is capable of up to 5% strain recovery and 50,000 psi restoration stress with many cycles. By example, a Nitinol wire 0.020 inches in diameter can lift as much as 16 pounds. Nitinol also has the resistance properties which enable it to be actuated electrically by joule heating. When an electric current is passed directly through the wire, it can generate enough heat to cause the phase transformation. In most cases, the transition temperature of the SMA is chosen such that room temperature is well below the transformation point of the material. Only with the intentional addition of heat can the SMA exhibit actuation. In essence, Nitinol is an actuator, sensor, and heater all in one material.

Shape memory alloys, however, are not for all applications. One must take into account the forces, displacements, temperature conditions, and cycle rates required of a particular actuator. The advantages of Nitinol become more pronounced as the size of the application decreases. Large mechanisms may find solenoids, motors, and electromagnets more appropriate. But in applications where such actuators cannot be used, shape memory alloys provide an excellent alternative. There are few actuating mechanisms which produce more useful work per unit volume than Nitinol.

Nitinol is available in the form of wire, rod and bar stock, and thin film. Examples of SMA products developed by TiNi Alloy Company include silicon micro-machined gas flow microvalves, non-explosive release devices, tactile feedback device (skin stimulators), and aerospace latching mechanisms. If you are considering an application for shape memory alloys, TiNi Alloy Company can assist you in the design, prototyping, and manufacture of actuators and devices.

2.4 HISTORY OF SHAPE MEMORY ALLOY

In1932, a Swedish physicist by the name of Arne Olander discovered an interesting phenomenon when working with an alloy of gold (Au) and cadmium (Cd). The Au–Cd alloy could be plastically deformed when cool and then be heated to return to, or "remember," the original dimensional configuration. This phenomenon is known as the shape memory effect (SME), and the alloys that exhibit the behaviour are called shape memory alloys (SMA).

In 1958, SME was demonstrated at the Brussels World's Fair, where the SME was used to cyclically lift a load mass. Researchers of U.S. Naval Ordnance Laboratory led by William Beuhler found SME in nickel-titanium (NiTi) alloy in 1961 by accident, while studying the heat and corrosion resistance of NiTi. Today, the NiTi alloys are commonly referred to as "Nitinol", for NiTi Naval Ordnance Laboratory. While testing an alloy of nickel and titanium for heat and corrosion resistance, they found that it too exhibited the SME. The Ni-Ti SMA proved to be significantly less expensive, easier to work with, and less dangerous (from a health stand point) than previously discovered alloys. These factors refreshed interest and research in the shape memory effect and its applications.

Researchers, designers, and companies recognized the potential to use the SME in engineering applications. As a result, starting in the 1970s, commercial products began to emerge. First devices were static, taking advantage of a single dimensional change, for example fasteners, couplings for piping systems and electrical connectors took advantage of a single shape memory dimensional change. Then, SMA devices started to perform dynamic tasks as actuators. Ambient