ING DC MOTOR POSITION CONTROL

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MAY 2008

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

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Date : 7 MAY 2008

MODELING DC MOTOR POSITION CONTROL

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This Report Is Submitted In Partial Fulfillment of Requirements for The Degree of Bachelor in Electrical Engineering (Industry Power)

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To my beloved parents and friends
For their support, prayer and inspiration
to me

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Assalamualaikum W.B.T

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ABSTRACT

This project aims to modeling a DC Motor Position Control. DC motor is a machine that change form electrical energy to mechanical energy. It is suitable to use in robotic industries, manufacturing equipment and others because the cost is low than AC motor. When modeling DC motor position control, a physical parameter such as moment of inertia of the rotor (J) , damping ratio of the mechanical system (b), electromotive force constant (K=Ke=Kt) , electric resistance (R) , electric inductance (L) and others is measured . Then, a simulation of DC motor position control by using MATLAB to get the output response. After that, by using oscilloscope, all the direct measurement of the output response is defined. Lastly, all the output response of modeling DC motor position control will be compared and analyzed. So, a good and perfect modeling of DC motor position control can be developed. As a result from this project we can model the DC motor position control properly and suitable for the system.

ABSTRAK

Projek ini bertujuan untuk memodelkan motor berarus terus pengawalan kedudukan. Motor arus terus adalah satu mesin yang menukarkan tenaga elektrik kepada tenaga mekanikal. Iannya sesuai digunakan di dalam industri robotic, alatan pembuatan dan sebagainya kerana kos lebih murah berbanding motor arus ulang-alik. Untuk memodelkan motor arus terus, parameter fizikal seperti inersia (J), nisbah redaman tenaga mekanikal (b), pemalar daya gerak elektrik (K=Ke=Kt),rintangan elektrik (R), induktans elektrik (L) dan sebagainya diukur. Selepas itu, analisis untuk motor arus pengawal kedudukan dibuat dengan menggunakan MATLAB untuk mendapatkan respon keluaran. Selepas itu, dengan menggunakan osciloskop,semua respon keluaran diukur secara langsung. Selepas itu, semua respon keluaran untuk motor arus terus pengawalan kedudukan dianalisis dan dibandingkan. Oleh itu, motor arus terus pengawalan kedudukan yang terbaik dan bagus dicipta. Sebagai keputusan daripada projek ini, kita boleh memodelkan motor arus terus yang terbaik dan sesuai untuk sesuatu sistem.

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CHAPTER 1

INTRODUCTION

1.1 1ntroduction

Nowadays, DC motor is widely used in industry such as for speed control, position control and others. A DC motor is designed to run on DC electric power. It is a conversion of electrical energy into mechanical energy by electromagnetic. DC motor is suitable to use in robotic industries, manufacturing equipment and others because the cost is low than AC motor. By modeling a DC motor for position control by using all the method, an accurate and consistent of dc motor position control will be developed.

1.2 Problem statement

Nowadays in industry, most factory are using a machine with DC motor to help the people to make what they want. It is because DC motor is suitable to use in robotic industries, manufacturing equipment and others because the cost is low than AC motor. To model a DC motor position control, all the method such as using data collection and mathematical modeling, simulation using MATLAB, direct measurement using oscilloscope and interfacing with DAS will be use. So, from this project it was easy to see the DC motor position control work and its function. Beside that, it can easily to learn more about the Direct Association system (DAS), software (MATLAB) and how to get a direct measurement by using oscilloscope.

1.3 Objective

To make sure this project goes well and follow planning that have been made, some objectives are identified as end of the project objective. In among stated objectives is:

1. To make a data collection and mathematical modeling.

2. To make a simulation of DC motor position control by using MATLAB software.

3. To make an analysis from the comparison of output response between simulations using MATLAB, direct measurement using oscilloscope and interfacing with DAS.

4. To compare the result from these three method.

1.4 Scope

To know all the function of DC motor position control, a literature study and reference about a DC motor has been made. Main component such as DC motor 30V, oscilloscope and others are used to build this project. This project also uses MATLAB software use to make simulation, doing data collection and mathematical modeling, direct measurement using oscilloscope and interfacing with DAQ card.

CHAPTER 2

LITERATURE REVIEW

2.1 Basic Motor Theory

It has been said that if the Ancient Romans, with their advanced civilization and knowledge of the sciences, had been able to develop a steam motor, the course of history would have been much different. The development of the electric motor in modern times has indicated the truth in this theory. The development of the electric motor has given the most efficient and effective means to do work known. Because of the electric motor people have been able to greatly reduce the painstaking toil of people's survival and have been able to build a civilization which is now reaching to the stars.

The electric motor is a simple device in principle. It converts electric energy into mechanical energy. Over the years, electric motors have changed substantially in design. However the basic principles have remained the same.[6]

2.1.1 Magnetism

A permanent magnet will attract and hold metal objects when the object is near or in contact with the magnet. The permanent magnet is able to do this because of its inherent magnetic force which is referred to as a "magnetic field". In Figure 2.1, the magnetic fields of two permanent magnets are represented by "lines of flux". These lines

of flux help to visualize the magnetic field of any magnet even though they only represent an invisible phenomenon.

The number of lines of flux varies from one magnetic field to another. The stronger the magnetic field, the greater the number of lines of flux which are drawn to represent the magnetic field. The lines of flux are drawn with a direction indicated since it should visualize these lines and the magnetic field they represent as having a distinct movement from an N-pole to a S-pole as shown in Figure 2.1. Another but similar type of magnetic field is produced around an electrical conductor when an electric current is passed through the conductor as shown in Figure 2.2. These lines of flux define the magnetic field and are in the form of concentric circles around the wire. It also had shown "Left Hand Rule".

In Figure 2.2, the rule states that if the point the thumb of left hand in the direction of the current, a finger will point in the direction of the magnetic field.

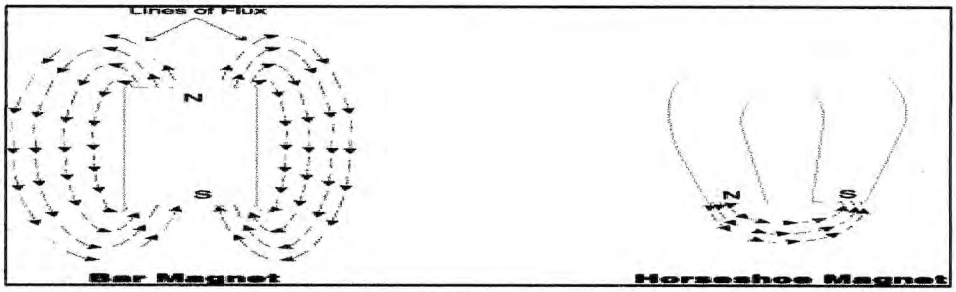

Figure 2.1: The lines of flux of a magnetic field travel from the N-pole to the S-

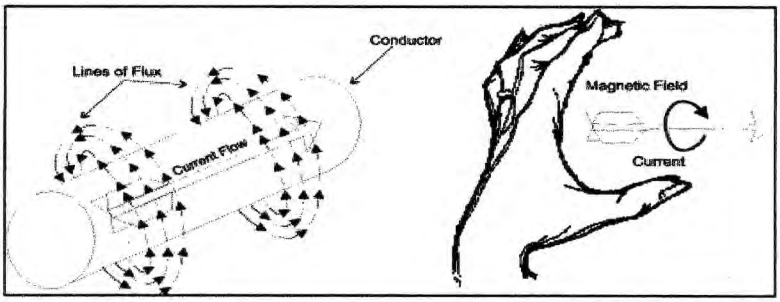

Figure 2.2: The flow of electrical current in a conductor sets up concentric lines of magnetic flux around the conductor

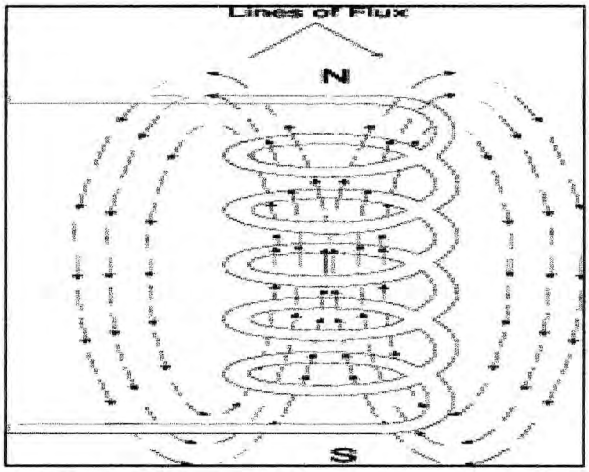

Figure 2.3: wire is shaped into a coil

When the wire is shaped into a coil as shown in Figure 2.3, all the individual flux lines produced by each section of wire join together to form one large magnetic field around the total coil. As with the permanent magnet, these flux lines leave the north of the coil and re-enter the coil at its south pole. The magnetic field of a wire coil is much greater and more localized than the magnetic field around the plain conductor before being formed into a coil.

This magnetic field around the coil can be strengthened even more by placing a core of iron or similar metal in the center of the core. The metal core presents less resistance to the lines of flux than the air, thereby causing the field strength to increase. (This is exactly how a stator coil is made; a coil of wire with a steel core.) The advantage of a magnetic field which is produced by a current carrying coil of wire is that when the current is reversed in direction the poles of the magnetic field will switch positions since the lines of flux have changed direction.[6]

2.1.2 Magnetic Propulsion Within A Motor

The basic principle of all motors can easily be shown using two electromagnets and a permanent magnet. Current is passed through coil no. 1 in such a direction that a north pole is established and through coil no. 2 in such a direction that a south pole is

established. A permanent magnet with a north and South Pole is the moving part of this simple motor.

In Figure 2.4-a, north pole of the permanent magnet is opposite the north pole of the electromagnet. Similarly, the south poles are opposite each other. Like magnetic poles repel each other, causing the movable permanent magnet to begin to turn. After it turns part way around, the force of attraction between the unlike poles becomes strong enough to keep the permanent magnet rotating. The rotating magnet continues to turn until the unlike poles are lined up. At this point the rotor would normally stop because of the attraction between the unlike poles. (Figure 2.4-b)

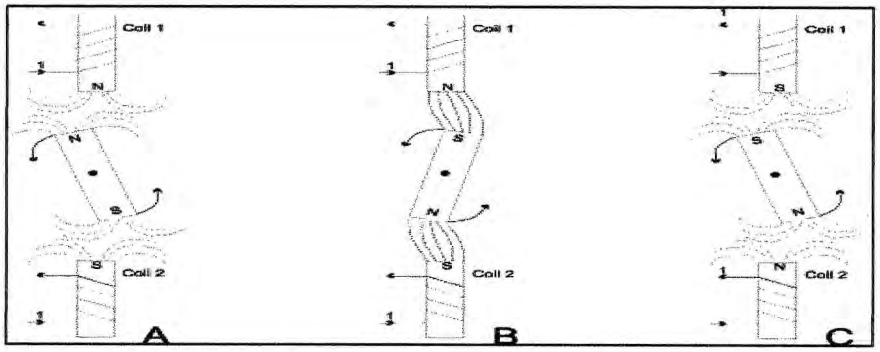

Figure 2.4: basic principle of all motors

If, however, the direction of currents in the electromagnetic coils was suddenly reversed, thereby reversing the polarity of the two coils, then the poles would again be opposites and repel each other. (Figure 2.4-c), the movable permanent magnet would then continue to rotate. If the current direction in the electromagnetic coils was changed every time the magnet turned 180 degrees or halfway around, then the magnet would continue to rotate. This simple device is a motor in its simplest form. An actual motor is more complex than the simple device shown above, but the principle is the same.

2.2 DC Motor Theory

The first generators and motors were called dynamos or dynamoelectric machines. Dynamo is from the Greek word dynamist which means power. Webster defines dynamoelectric as "relating to the conversion of mechanical energy into electrical energy or vice versa". The word motor is from the Latin word motus which means one that imparts motion or prime mover. The dynamo was the result of the efforts of several people, in different countries, in the mid-nineteenth century, to make electricity work for them.

2.2.1 Electrodynamics Principle

2.2.1.1 Faraday's Law

In order that current can be obtained from an electric circuit, an electromotive force (voltage) must be established and maintained between the two ends of the circuit. This electromotive force may be established in several ways, one of which is by means of an electromagnetic generator.

Michael Faraday discovered that an electric potential can be established between the ends of a conductor in the following three ways:

- By a conductor moving or cutting across a stationary magnetic field. (DC Generator)
- By a moving magnetic field cutting across a stationary conductor. (AC Generator)
- By a change in the number of magnetic lines enclosed by a stationary loop or Coil. (Transformer)

Faraday's law states that, "the EMF (electromotive force) induced between the ends of a loop or coil is proportional to the rate of change of magnetic flux enclosed by the coil; or the EMF induced between the ends of a bar conductor is proportional to the time rate at which magnetic flux is cut by the conductor." This law emphasizes rate of change or rate or flux cutting rather than density or extent of magnetic field.[1]

2.2.1.2 Lenz's Law

Lenz's Law states that, "A change in the magnetic flux passing through or linking with, a loop or coil causes EMF to be induced in a direction to oppose any change in circuit conditions, this opposition being produced magnetically when current flows in response to the induced EMF." Whenever there is a change in current in a magnetizing coil, which works to change the flux in the coil, a voltage is induced which tends to prevent the change. Thus, if we attempt to diminish the current flowing in a magnetizing coil, a voltage will be developed that will tend to keep the current unchanged. Likewise, if we attempt to establish a current in a magnetizing coil, a voltage will be developed that will tend to keep the current from increasing.[1]

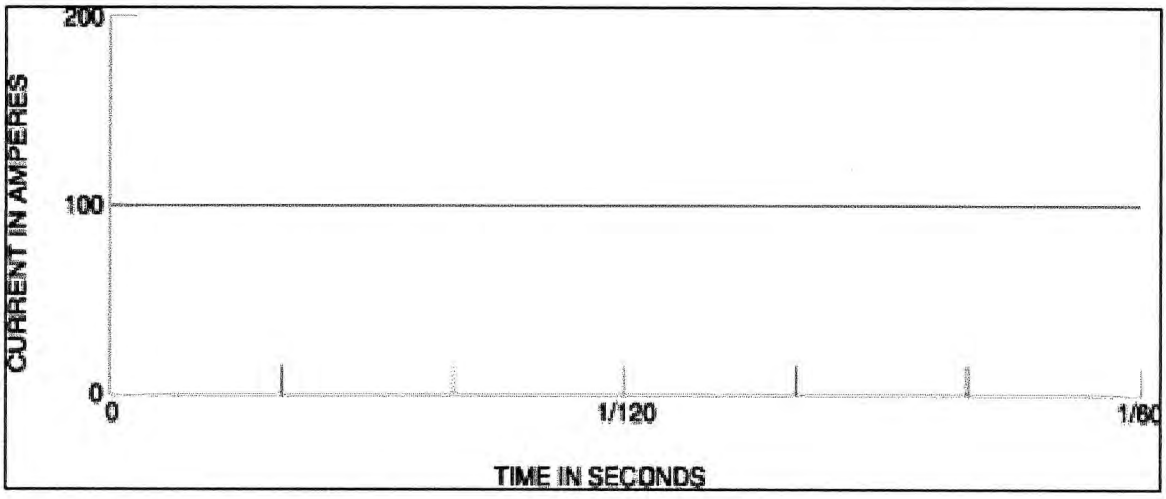

Figure 2.5: Current Dc Motor