

**DEVELOPMENT OF MAGNETIC BEARING SYSTEM MODEL FOR
PRACTICAL-BASED APPLICATION**

WAN AHMAD SYAKIR BIN WAN MOHAMAD KAMIL

**This report is submitted in partial fulfillment of the requirements for the award of
Bachelor of Electronic Engineering (Computer Engineering) With Honours**

**Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka**

May 2008



UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Development of Magnetic Bearing System Model for Practical-Based Application
Sesi Pengajian : 2008

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TIDAK TERHAD

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(TANDATANAN PENULIS)

Alamat Tetap: 32, Jalan SS7/5, Kelana Jaya

47301 Petaling Jaya

Selangor

Tarikh: 21 April 2008

(COP DAN TANDATANAN PENYELIA)

SHARATUL IZAH BT SAMSUDIN

Pensyarah

Fakulti Kej Elektronik dan Kej Komputer (FKEKK),


Universiti Teknikal Malaysia Melaka (UTeM),

Karung Berkunci 1200,

Ayer Keroh, 75450 Melaka

Tarikh: 9 Mei 2008

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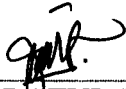
Signature : 

WAN AHMAD SYAKIR BIN WAN

Author : MOHAMAD KAMIL

Date : 21 / 04 / 2008

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Signature : 
PUAN SHARATUL IZAH BINTI

Supervisor's Name : SAMSUDIN

Date : 21 / 04 / 2008

For my dear beloved father, mother and my entire family.

APPRECIATION

Syukur to Allah, because of His bless, I had successfully finish my Projek Sarjana Muda. I also want to take this opportunity to give appreciation to all that involve and helping me along my progress in completing my project includes my supervisor, lecturer, my family and my entire friend. Million thanks to all and May Allah award and bless all of you. Thank you.

ABSTRACT

The main objective of this project is to study the characteristic and design a magnetic bearing system for practical-based application. MBC500 model is used as a reference model. Magnetic bearing system is a bearing system which supports a rotor using electromagnetic force. It supports moving machinery without physical contact. It is widely use in such industrial applications as jet engines, compressors, pumps, and flywheel systems that are required to meet high speed, low vibration, zero frictional wear, and clean environment specifications. Magnetic bearing system model for practical based application is build by studying its characteristic and then run the simulation circuit design of this model. The main parts of component are active radial magnetic bearing, rotor, controller circuit, power or current amplifier circuit and Hall-effect sensor. At the end of the project, magnetic bearing system model will be test and troubleshoot before the design model is successfully complete.

ABSTRAK

Projek ini bertujuan untuk mengkaji ciri-ciri dan membina model untuk sistem bering magnetik untuk tujuan aplikasi latihan. Model bagi sistem bering magnetik ini dikaji ciri-cirinya dan dibina dengan menggunakan model bebola magnetik MBC500 sebagai model rujukan. Sistem bering magnetik ialah suatu sistem yang membolehkan suatu mesin yang bergerak tidak mengalami sentuhan secara fizikal. Antara kelebihan bering magnetik adalah ianya hanya mengalami kerosakan yang sedikit dan boleh dijangkakan, disamping mampu beroperasi tanpa pelincir. Penggunaan bearing magnetik semakin meningkat di dalam mesin perindustrian seperti pemampatan, turbin, pengepaman, motor dan mesin penjana. Model bagi sistem bering magnetik untuk tujuan aplikasi latihan dibina dengan mengkaji ciri-ciri tertentu bagi model ini dan kemudian menjalankan simulasi reka bentuk litar model ini. Bahagian utama bagi model sistem bering magnetik ini terbahagi kepada palang putar, sepasang bering magnetik aktif, litar pengawal, litar penguat arus atau kuasa dan pengesan kesan Hall. Pada akhir projek ini, pretasi model bering magnetik akan diuji dan dijalankan pemantapan sebelum model ini akan diputuskan selesai atau tidak.

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LIST OF ABBREVIATION

DSP	-	Digital Signal Process
PIC	-	Peripheral Interface Controller
AMB	-	Active Magnetic Bearing
IC	-	Integrated Circuit
PSM1	-	Projek Sarjana Muda 1
PSM2	-	Projek Sarjana Muda 2
PCB	-	Printed Circuit Board
BJT	-	Bipolar Junction Transistor
DC	-	Direct Current

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CHAPTER I

INTRODUCTION

For this chapter, it will tell about the introduction of the project, development of magnetic bearing system for practical based application. Including in this chapter is the overview of this project, objective of the project, problem statement and scope of this project.

1.1 Overview

Magnetic bearing is a device that uses electromagnetic forces to support a rotor without mechanical contact. Magnetic bearings can be divided into two categories- active and passive. Magnetic Bearings have been widely used in a rapidly growing number of applications such as jet engines, compressors, pumps, and flywheel systems that are required to meet high speed, low vibration, zero frictional wear, and clean environment specifications.

For this project, the development of magnetic bearing system model for practical-based application is proposed since two control approaches are offered. The

characteristics and modeling of the system is studied first. Then, the model of magnetic bearing system will be constructed.

1.2 Problem statement

Magnetic bearing system is bearing system which supports a rotor using electromagnetic force. Magnetic bearings support moving machinery without physical contact. It is widely use in such industrial applications as electric power generation, machine tool operation and transportation such as bullet train. Compared with the typical bearing system, it has many advantages. Magnetic bearing system offer low cost maintenance compared to typical bearing system because lubrication in operation system doesn't need to be replace when it is exhausted like typical bearing system. Magnetic bearing system offer solution of pollution which is usually produced by typical bearing system.

1.3 Objective

The objectives of this project are:

- To study and analyze the characteristic of the magnetic bearing system for practical-based application.
- To develop the model of magnetic bearing system for practical-based application.

1.4 Scope

For the scope of project, development of magnetic bearing system model for practical-based application is covered for this area:

- Study and analysis the characteristic of the magnetic bearing system for practical-based application of MBC500.
- Identify the component for the development of magnetic bearing system model for practical-based application of MBC500.
- Develop the model of magnetic bearing system of MBC500.
- Test and troubleshoot the model of magnetic bearing system of MBC500.

As it state in the scope, MBC500 will be used as a reference model for this project.

1.5 Report structure

This report starts with the literature review about magnetic bearing, magnetic bearing system and basic operation of magnetic bearing system, MBC500 model and characteristic of MBC500 model. Next chapter will cover about the project methodology on the process to develop the model of magnetic bearing system for practical-based application. Then, all the result will be discuss in the next chapter. Project hypothesis will be done to decide either the project had achieved the objective or not. Lastly, the conclusion and also the suggestion on this overall project will be including in this report.

CHAPTER II

LITERATURE REVIEW

In this chapter, it will tell about background research or literature review about magnetic bearing, magnetic bearing system and basic operation of magnetic bearing system and also about MBC500 magnetic bearing system model. One of an important thing that must know before develop a model of magnetic bearing system is a magnetic bearing system and its characteristic.

2.1 Magnetic bearing

Magnetic bearing is a device that uses electromagnetic forces or magnetic levitation to support a rotor or a load [7]. Its support rotor without physical contact, for example, they can levitate a rotor or rotating shaft and permit relative motion without friction or wear [7]. Magnetic bearings can be divided into two categories- active and passive. An active magnetic bearing basically use temporary magnet, as an electromagnetic force can be change or varied through the current change. A passive magnetic bearing basically use permanent magnet, as an electromagnetic force become constant and can't be changed even by the current change.

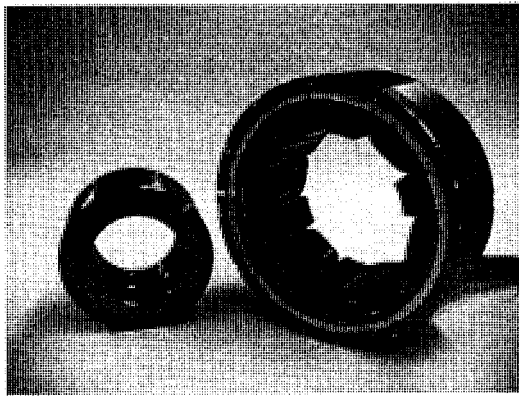


Figure 2.1: A magnetic bearing

Magnetic bearing has been widely use in many industrial applications such as compressors, turbines, pumps, motors and generators. It also use in another application such as jet engines, compressors, pumps, and flywheel systems that are required to meet high speed, low vibration, zero frictional wear, and clean environment specifications. A very interesting new application of magnetic bearings is their use in artificial hearts.

The evolution of magnetic bearings may be traced through the patents issued in this field. The table below lists several early patents for magnetic bearings, especially for active magnetic bearing [7].

Table 2.1: Early U.S patent of active magnetic bearing

Inventor	Year	Patent No.	Invention Title
Beams, Holmes	1941	2,256,937	Suspension of Rota table Bodies
Beams	1954	2,691,306	Magnetically Supported Rotating Bodies
Beams	1962	3,041,482	Apparatus for Rotating Freely Suspended Bodies
Beams	1965	3,196,694	Magnetic Suspension System
Wolf	1967	3,316,032	Poly-Phase Magnetic Suspension

			Transformer
Lyman	1971	3,565,495	Magnetic Suspension Apparatus
Hubermann	1973	3,731,984	Magnetic Bearing Block Device for Supporting a Vertical Shaft Adapted for Rotating at High Speed
Hubermann, Loyer, Joli, Aubert	1974	3,787,100	Devices Including Rotating Members Supported by Magnetic Bearings
Hubermann, Brunet	1977	4,012,083	Magnetic Bearings
Hubermann, Brunet, LeClère	1978	4,114,960	Radial Displacement Detector Device for a Magnetic Bearings

2.2 Magnetic levitation

Magnetic levitation or magnetic suspension is a method by which an object is suspended with no support other than magnetic fields. The electromagnetic force is used to counteract the effects of the gravitational force. The forces acting on an object in any combination of gravitational, electrostatic, and magneto static fields will make the object's position unstable.

There are several methods to obtain magnetic levitation. One of the methods is a mechanical constraint. If two magnets are mechanically constrained along a single vertical axis (a piece of string, for example), and arranged to repel each other strongly, this will act to levitate one of the magnets above the other. This is considered pseudo-levitation.

There is many application that using the magnetic levitation. One of the applications is a magnetic bearing. Magnetic bearing use magnetic levitation to support

the rotor. Another application is like bullet train when magnetic levitation levitate the train tire to move it.

2.3 Magnetic bearing system

Magnetic bearing system is bearing system which supports a rotor or a load using electromagnetic force or magnetic levitation. The main component part of magnetic bearing system consist of a pair of magnetic bearing, position or gap sensor, a set of power amplifier and a controller.

Magnetic bearing system has many advantages compared to typical bearing system that not use electromagnetic force to support rotor or load. Magnetic bearing system offer low cost maintenance compared to typical bearing system because lubrication in operation system doesn't need to be replace when it is exhausted like typical bearing system. Magnetic bearing system offer solution of pollution which is usually produced by typical bearing system.

For application, it is has widely uses in such industrial applications as electric power generation, machine tool operation and transportation such as bullet train.

2.3.1 Basic operation of magnetic bearing system.

As it said earlier, magnetic bearing system consists of a pair of magnetic bearing, position or gap sensor, a set of power amplifier and a controller. Figure 2.2 below show the operation of magnetic bearing system that use active magnetic bearing.