Preface

Owing to rapidly increasing energy costs and global interest in reducing carbon dioxide emissions, electric motors have recently become one of the most important prime movers that produce mechanical power. Recently, in many mechanical systems, traditional prime movers such as a hydraulic system, a steam turbine, a gas turbine, and an internal combustion engine are being rapidly replaced by electric motor drive systems, which are more efficient, controllable, and environment-friendly. Currently, electric motor drive systems are playing an important role in improving convenience in many areas of our lives including home appliances, office machines, transportation, and industrial machines.

The main aim of this book is to introduce practical drive techniques of electric motors for supporting stable, efficient control of such application systems, covering basic principles to high-performance motor control techniques.

Nowadays, the most widely used motors are classic direct current (DC) and alternating current (AC) motors (induction motor and synchronous motor). Besides these motors, there is a brand new brushless direct current (BLDC) motor. To control these motors efficiently, we will do a comprehensive study of fundamental operating principles, driving methods of electric motors, related control theories, and power converters for driving a motor. Many people do not have the background knowledge in these areas and may need to obtain these contents from various books. Therefore, this book is designed optimally for studying these contents at once and easy learning of difficult control principles. Furthermore, this book provides simulation examples for key subjects using MATLAB/Simulink tool and offers practical control techniques for industrial motor drive applications currently in use.

This book is the English version of my book titled *DC, AC, BLDC Motor Control*, which was first published in August 2007, in Korean. This book is based on my wide research experience in the electric motor control field over the past 20 years. During 20 years of teaching at my university, I realized that many students struggled with mastering the control of electric motors due to the complexity and difficulty of existing textbooks. Therefore, the main goal of this textbook was to address this issue by presenting the material in a straightforward way for the students to understand. As a result, this book gained popularity, and I received many appreciation letters from students and engineers after publishing the book, expressing gratitude for presenting the material well. I have also been invited many times to speak at seminars regarding the materials presented in the book.

The contents of this book are as follows.

Chapter 1, Fundamentals of electric motors, introduces the fundamental operating principle needed to understand electric motors and describes clear differences among the motors by comparing their operating principles.

Chapter 2, Control of direct current motors, describes DC motors, which used to be the typical motor for speed control and torque control, and the concept of

torque control for DC motors, which will be helpful for understanding the vector control for torque control of AC motors. Furthermore, this chapter goes into detail about the design of the current and speed controllers of DC motors, which is readily applicable to the current and speed controllers of AC motors.

Chapter 3, Alternating current motors: synchronous motor and induction motor, discusses the basic characteristics of AC motors, including synchronous and induction motors, which are widely used for industrial motors. These characteristics can provide a basis for studying high-performance motor control, which will be described later in the book.

Chapters 4−8 discuss the high-performance motor control systems of AC motors for industrial motor drive applications as follows:

Chapter 4, Modeling of alternating current motors and reference frame theory—the modeling of AC motors and $d-q$ reference frame theory for control of AC motors,

Chapter 5, Vector control of alternating current motors—the concept of the vector control and its implementation for AC motors,

Chapter 6, Current regulator of alternating current motors—the design of current controller for the vector control system,

Chapter 7, Pulse width modulation inverter—the PWM inverter and its various techniques for AC motor drives,

Chapter 8, High-speed operation of alternating current motors—the field-weakening control for high-speed operations of AC motors.

Chapter 9, Speed estimation and sensorless control of alternating current motors, describes the position/speed sensors and speed estimation required for the motor control. In additional, sensorless control, which is a state-of-the-art technique in the motor control area, is explored briefly.

Chapter 10, Brushless direct current motors) deals with BLDC motors, which are not classical motors but mostly used in small motor drive systems. The operation principle, drive methods, PWM methods, and sensorless control schemes of BLDC motors are also explored in detail.

Chapters 1−3, and 10 will be adequate for providing technical background of motor control for undergraduates in a one-semester course, while Chapters 4−9 will be suitable for graduate students and engineers with the necessary background for understanding high-performance motor control systems.

I am certain that this book will be able to equip one with complete techniques for controlling electric motors required for industrial applications.

The companion web site of the book can be found at: https://www.elsevier.com/books-and-journals/book-companion/9780128121382

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