SWITCHED RELUCTANCE MACHINES AND PERMANENT MAGNET DC BRUSHLESS MACHINES

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Summary

A conventional DC motor has brushes and commutators that are not reliable and require maintenance. The commutator limits its speed, and it also has noise and radio frequency interference problems. The DC motor is not suitable for use in a hazardous environment because sliding contact results in the potential for sparking. Nowadays, there are a number of brushless motors that have very attractive features including dynamic performance, high power density, and reduced cost. Typically available in the market are brushless DC motors and switched reluctance motors. They have become popular in industrial applications especially for low and medium drives. The main reason for their popularity is because recent developments in power electronics allow the complicated electronic control of these motors to be realized. The permanent magnet DC brushless motors are a replacement for the conventional brush-type DC motors because they use electronic switches to replace the brush. They are reliable and have a good dynamic response. Switched reluctance motors are now becoming very popular in many applications because they have the advantages of low manufacturing cost, good reliability, fault tolerance, wide range operation of speed and torque, and good dynamic

response. These motors can both run at very high speed. They are powered by DC and use electronic switches to deliver suitable signals to energize windings. They usually require a number of transistors for the switching. Typical applications are electric vehicles, actuators, servo drives, and robots.

1. Introduction

Commonly used motors can be classified into classical motors including the induction, synchronous, and permanent magnet brushed motors, and nonclassical motors including the switched-reluctance motor (SRM) and permanent magnet DC brushless motor (PMDCBLM). Classical motors, such as the synchronous and DC motors that require brushes or slip rings, still have a large market. The use of brushes or slip rings unfortunately reduces reliability and requires frequent maintenance. Induction motors are brushless, but complicated electronics and control methods are needed to operate them in order to provide variable speed operation. For this reason, many advanced control methods have been developed for the control of induction motors. In addition, induction motors also suffer from the inertia problem associated with windings required by the rotor and the stator. SRM and PMDCBLM were not popular in the past because they must be used together with power electronic circuits that provide pulse-width modulated signals to drive the motors. Unlike other classical motors, which can be operated directly on the AC or DC sources, both of these motors are operated from DC sources with a set of switching devices to control the winding voltage/current appropriately. They have become popular lately and they are widely used as power electronics has been developing rapidly over recent years. These motors can be designed in rotationary and linear types. They have similar principles but different applications. In the following text, the SRM and PMDCBLM are described in detail.

2. Rotationary Switched Reluctance Motor

2.1. Basic Information

Today, SRM is popular because of the rapid development of the microprocessor, digital signal processor, and ASIC. The design of SRM is less demanding as analytical tools such as the finite element analysis have become very common. The operation of SRM is usually software controlled. It can be run forward and backward by a motor as well as a generator. However, precise position monitoring is needed so that the necessary signals can be produced to energize the motor windings.

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Biographical Sketches

Dr. K.W.E. Cheng graduated from the University of Bath, UK, and obtained his Ph.D. in 1990. He has been project leader and principle engineer of Lucas Aerospace Ltd., UK. He joined the Hong Kong Polytechnic University in 1997 and is now an Associate Professor. His research interest is in all aspects of power electronics and drives. He has published more than 100 papers in these areas. Dr. Cheng is a Chartered Engineer, and a member of IEE and IEEE.

Dr. Norbert C. Cheung obtained his B.Sc., M.Sc., and Ph.D. from the University of London, University of Hong Kong and University of New South Wales in 1981, 1987, and 1996 respectively. From 1981 to 1985 he worked in the Advanced Manufacturing Department of General Electric (HK), and the Electronics Services Division, Hong Kong Productivity Council. During this period, he acted as the project leader for the development of Hong Kong's first photo plotter system; a high-precision numerically controlled light plotting machine for printed circuit board production. From 1985 to 1992 he worked as a lecturer and senior lecturer in the Department of Electrical Engineering at Hong Kong Polytechnic. From 1992 to 1995 he undertook a Ph.D. research study in the area of control and mechatronics at the University of New South Wales in Australia. Before he rejoined the Polytechnic University, he worked for two years as a Technical Manager at ASM Assembly Automation, in the areas of intelligent motion control and robotics systems for semiconductor manufacturing. Dr. Cheung is a Chartered Engineer, and a member of IEE and IEEE.

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