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Study of Noise Reduction of Switched Reluctance Motor in Traction and Industrial Applications

自動車駆動用および産業用スイッチドリラクタンスモータの騒音低減

Department of Electrical and Electronic Engineering

工学院 - 電気電子系

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チャンドラ　アディ　ウィグナ

Study of Noise Reduction of Switched Reluctance Motor in Traction and Industrial Applications

A THESIS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING AND THE COMMITTEE OF GRADUATE STUDIES OF TOKYO INSTITUTE OF TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTORAL OF ENGINEERING

Supervisor: Prof. Akira Chiba

By

Candra Adi Wiguna

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ABSTRACT

This thesis discusses two methods to reduce acoustic noise in switched reluctance motors. These methods are radial force sum flattening for traction 18/12 switched reluctance motor and a novel concept of selective radial force harmonics reduction for 6/10 switched reluctance motor for industrial application.

In case of radial force sum flattening, this thesis describes the improvement of the implementation from only low speed to middle speed operation by considering limited input DC voltage and high back electromotive force into the calculation process of current derivation. The effectiveness of the method is verified both in finite element analysis and experiment. The experimental results show a significant reduction by the improved current in the highest and second-highest peaks of noise at 5.4 kHz and 1.8 kHz by 11.04 dBA and 17.51 dBA, respectively, compared with a conventional single pulse current. The other peaks of noise are also reduced. By flattening radial force sum in middle speed, the overall noise reduction of 3.64 dBA is achieved.

In case of the second method, a novel method for vibration and acoustic noise reduction in a three-phase 6/10 switched reluctance motor is presented. The test machine has major vibration and acoustic noise at the 2^{nd}, 4^{th}, 5^{th}, 7^{th}, and 8^{th} harmonics. Accordingly, a novel method called “selective radial force harmonic reduction” is proposed. The proposed method selectively reduces the specific radial force harmonics at the stator teeth. By reducing the specific radial force harmonics such as 2^{nd}, 4^{th}, 5^{th}, 7^{th}, and 8^{th}, the corresponding vibration and acoustic noise can be reduced significantly in the test machine. Finite element analysis and experiments are conducted to verify the effectiveness of the proposed method. Compared with a conventional square current, the experimental results show that the overall sound pressure level is reduced by 7.1 dBA using the proposed method at the rated speed and torque. The dynamic conditions of the test machine using the proposed method are also presented.

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