Vibration Analysis and Prediction of Switched Reluctance Motor by Experimental Transfer Function Coupled with Finite Element Method

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***Abstract* — This paper proposes the vibration analysis of Switched Reluctance Motor (SRM) by the experimental transfer function coupled with electromagnetic Finite Element Method (FEM). This function is measured by the response of vibration to harmonic current components. Then the electromagnetic and vibration characteristics according to switching angle are investigated to reduce mechanical vibrations.**

INTRODUCTION

The practical use of SRMs in industrial applications is limited by their higher vibration and torque ripple. The interaction of electromagnetic forces and mechanical structure is the major cause of noise and vibration. The drive strategy approach to reduce the vibration includes current waveform, turn-off and on angles, duty cycle, etc. [1] Therefore, in order to reduce the vibration, it is necessary to predict the vibration level caused by the electromagnetic phenomenon under control techniques. Generally, the vibration characteristics are evaluated by the coupled electromagnetic and structural analysis based on the numerical method [2].

In this paper, the experimental transfer function instead of the structural FEM is coupled with the electromagnetic FEM to predict the vibration level emitted from the SRM according to control method. The experimental transfer function is defined as the vibration level versus harmonic current components. This function is measured by the response of acceleration to harmonic current components. It represents the inherent properties of the SRM. Based on this function, the vibration level is calculated very easily, accurately and simply by the current that is obtained from the electromagnetic FEM. From the proposed method, this paper investigates the relationship between the electromagnetic and the vibration characteristics according to switch on and off angles. In addition, a proper switching angle is presented to produce a less vibration while preserving torque and efficiency.

ANALYSIS PROCEDURE AND RESULTS

The analysis model is a 6/4 SRM with three phases winding. Fig. 1 presents the analysis process for the experimental transfer function coupled with electromagnetic FEM that helps to evaluate the mechanical and electromagnetic performances of motor controlled by the switching angle. Fig. 2 shows the variation of torque and vibration level for switching on and off angle, which is obtained from the proposed method. Fig. 3 shows the measured torque and vibration varying with the switching on angle. The SRM produces the low vibration and high torque when switch is on at 16 (deg.).

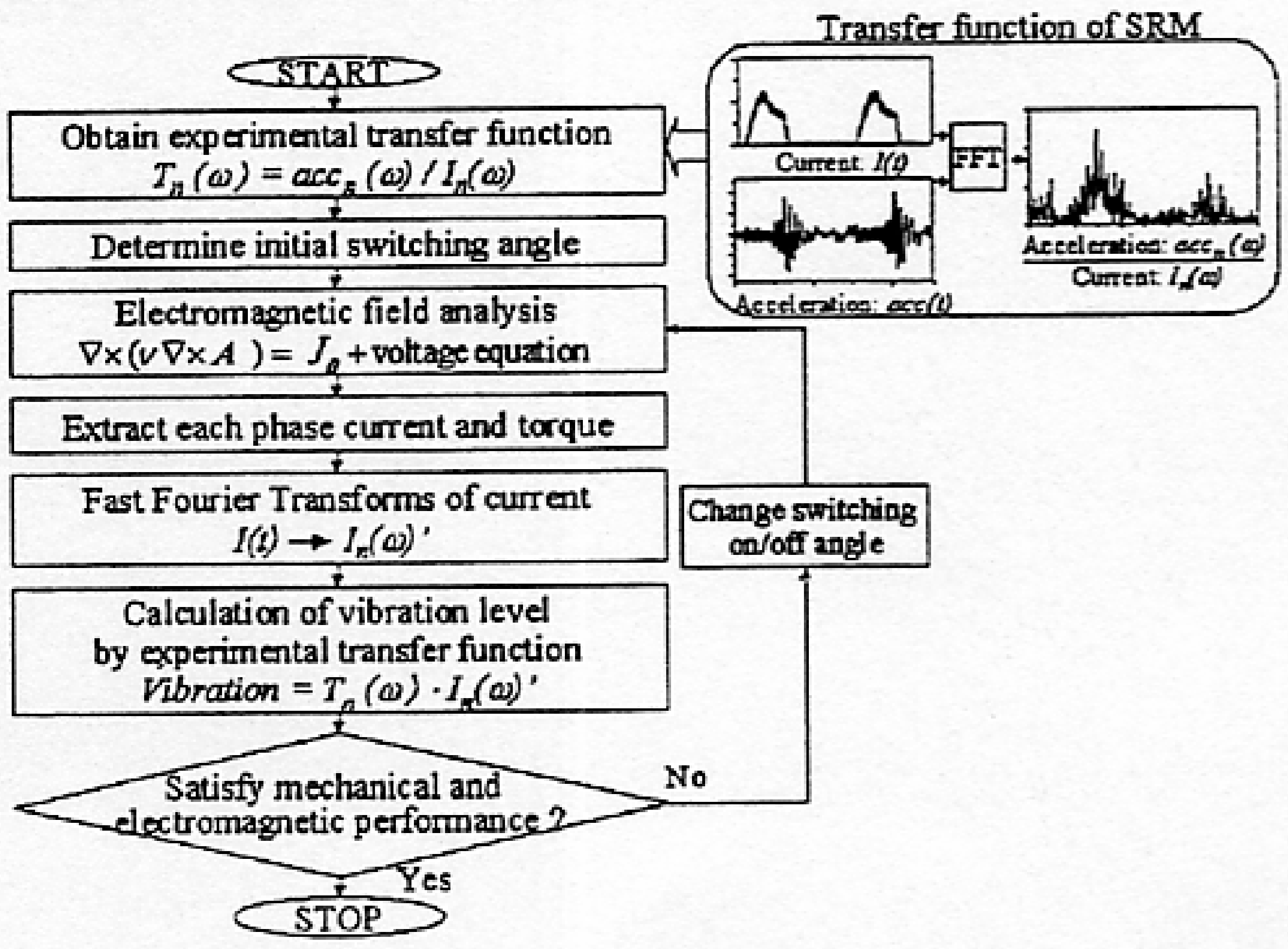

Fig. 1 Analysis flow for predicting the vibration caused by switching angle

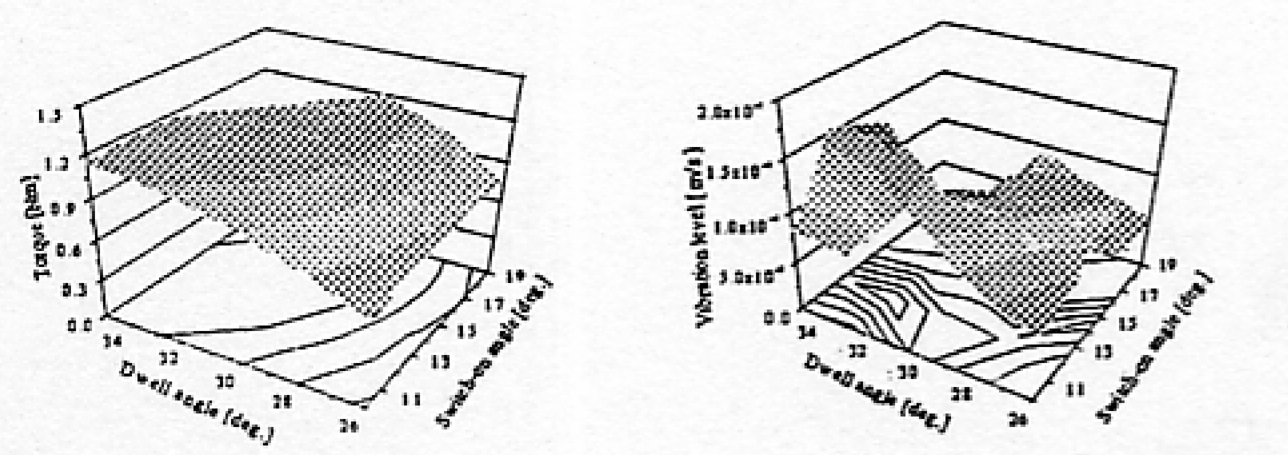

Fig. 2. Variation of torque (left) and overall vibration level (right) for switching on and off angle

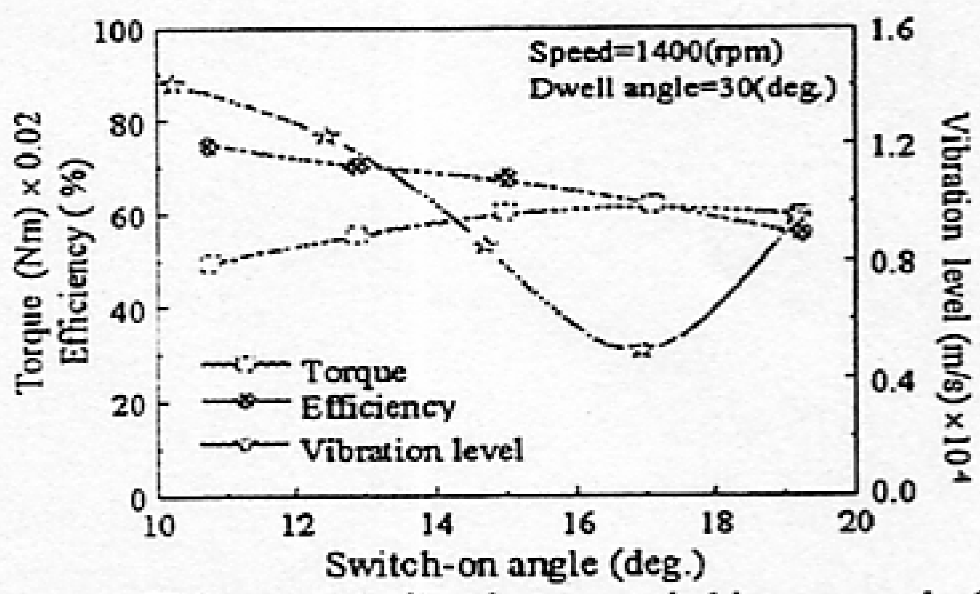

Fig. 3. Torque, efficiency and vibration vs. switching on angle (measured data)

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