INVESTIGATION OF VARIOUS MODULATING TECHNIQUE FOR VECTOR CONTROLLED INDUCTION DRIVES

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Abstract— This paper focuses on the various strategies involved in control of induction motor vector drives. The various PWM techniques presently being used and their relative merits and demerits are discussed. Various controllers' like fuzzy and ANN are also discussed to that are presently applied to modern electric drives.

Index Terms— ANN controller, Common Mode Voltage, Fuzzy controller, Scalar PWM, SVPWM.

INTRODUCTION

Induction motors are the main workhorse of an industry due to their robust construction and ease in industrial drives speed control. Hence power electronic converters are used as an interface between the grid supply and the electric motors [1]. In a balanced three phase sinusoidal supply, the zero sequence voltage or the voltage between the ground and neutral point is zero. But, in a PWM technique based three-phase voltages, the voltage between the ground and neutral will be present. This voltage is known as zero sequence voltage or common mode voltage (CMV). The magnitude of the CMV will depend on the applied voltage vector and may vary between ± 270 [1]. This will cause deteriorate of the motor windings and motor by large.

Due to the advancement of power electronics PWM techniques are involved in the control of induction motors. The foregoing PWM methods are discussed below.

II. Conventional PWM methods

Space Vector PWM

Among the various PWM conventional techniques, SVPWM is superior performance characteristic when compared with other PWM techniques, in this approach, the implementation is straight forward but quite laborious, me switching losses, the classical space vector approach requires the calculation of angle and sector information in order to generate pulses or modulating signals. Thus it takes more memory for calculation purpose.

To reduce complexity and reduce size a unified modulation scalar approach technique is introduced which is discussed in the proceeding section.

Scalar PWM Approach

Based on the above discussed demerits of conventional PWM techniques, new scalar based techniques are introduced to overcome the demerits in the conventional PWM techniques.

The principle of scalar approach based PWM techniques is volt – time balance per carrier cycle.

The generalized scalar PWM approach provides degrees of freedom in the choice of both the zero-sequence signal and the carrier waves [2].

In the scalar representation, using the zero-sequence signal injected modulation waves; the duty cycle of each switch can be easily calculated.

In [2] the generalized scalar approach yields a simple and powerful implementation with modern control chips which have digital PWM units. With this approach, it becomes an easy task to program the pulse patterns of various high performance PWM methods and benefit from their performance in modern VSIs for applications such as motor drives.

The research has been focused on the development of various PWM algorithms for the

reduction of common mode voltage which are also known as reduced common mode voltage PWM (RCMVPWM) algorithms.

In all RCMVPWM algorithms, the usage of the zero voltage vectors is avoided and hence, these algorithms give CMV of $\pm Vdc/6$. The RCMVPWM algorithms can be divided into three groups [2]:

- Active Zero State PWM (AZSPWM)
- Remote State PWM (RSPWM)
- Near State PWM (NSPWM)

In order to create a zero voltage vector, the AZSPWM algorithms use the two active states with equal times, which are in opposite to each other. The RSPWM algorithms synthesize the output voltage from three inverter voltage vectors that are 120° apart from each other. The NSPWM technique utilizes a group of three neighbor voltage vectors to generate the reference voltage vector [3]. By injecting different zero-sequence signals, various PWM methods with different characteristics can be generated. Note here that only one triangular carrier wave is utilized.

Among the RCMV-PWM methods, AZSPWM methods and NSPWM provide high performance. AZSPWM1 and AZSPWM3 limit CMV to $\pm Vdc/6$ they have better CMV and CMC characteristics compared to SVPWM.

In AZSPWM methods, instead of one carrier wave, two carrier waves (Vtri and –Vtri) must be utilized. The implementation of AZSPWM1 and AZSPWM3 is quite easy by using triangular intersection technique.

In the scalar implementation the modulation waves can be generated with a fewer number of computations (magnitude tests) and PWM methods can be implemented with a microcontroller or DSP. Due to the simplicity of the algorithms, it is easy to program two or more methods and on-line select a modulator in each operating region in order to obtain the highest performance [2].

Artificial intelligence such as i) Artificial Neural Network (ANN), Genetic algorithm (GA) and Fuzzy Logic control (FLC) or combinations among them are become important techniques to extract the ultimate performance of modern motors [3-4]. FLC is used and implemented in controlling of switching techniques, due to its simple structure and good results in area of control [4]. FLC is a process of employing fuzzy logic concept in system control applications. Fuzzy logic deals with the concept of partial truthness, it can be thought of as he super set of the conventional, true or false Boolean logic. Fuzzy logic approach allows the designer to handle efficiently very complex closed loop control problems, reducing in many cases engineering time and cost. Also it supports non linear design techniques that are now being used in motor control applications; Moreover FLC relatively needs less computation then ANN and GA.

The application of Artificial Neural Network (ANN) is recreantly growing in power electronics and drives area. ANN is computational model based on structure and functions of biological neural network [5]. ANN is made up of interconnecting neurons which are programmed like to mimic the properties of biological neurons. It is configured for solving Artificial intelligence problems without creating a model of real biological system.

The long evolution given many best and excellent characteristics to engineer applications such as

- Adaptability
- Leaning ability
- Generalization ability
- The fault tolerance
- Low energy consumption.

Conclusion:

The paper gives an insight to effectively incorporate various PWM techniques and controllers including Fuzzy and ANN. The techniques can be used to reduce CMV in FOC controlled induction drives. This paper also serves as an eye opener for researchers in the field of electrical engineering.

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