Chapter 6
Hybridized Genetic Algorithm Based Machine Parameters Estimation for Direct Torque Control of 3 Phase Motor for Wind Energy Systems

Vivek Venkobarao
IEEE Senior Member, India

ABSTRACT
It is generally aware that real-time parameter estimation of A.C. induction machine is very important for the efficient operation of vector-controlled drives. However, most existing methods have not taken into account of the four imperfections within the system, i.e. the existence of severe power harmonics due to the PWM inverter drive, the imbalancing of the 3-phase supply from the inverter, the variation of supply frequency under load changing and acceleration/deceleration, and changes in resistance. In this example, we have developed a new method of parameter estimation based on real time data sampling of voltages and currents, no matter they are sinusoidal or not. Here, the assumption of a synchronous rotating speed of the stator flux is not critical. With the aid of hybrid genetic algorithm techniques, the model has been found useful for on-line speed/torque control in most field orientation control schemes as it is much easier to achieve a global minimum during the optimization process.

INTRODUCTION

Basic Principle of DTC
In principle, DTC is a direct hysteresis stator flux and electromagnetic torque control which triggers one of the eight available discrete space voltage vectors generated by a Voltage Source Inverter (VSI) in order to keep stator flux and motor torque within the limits of two hysteresis bands. The correct application of this principle allows a decoupled control of flux and torque. Basically, the status of the errors of stator flux magnitude $|\psi_s|$ and electromechanical torque $T_e$ are detected and digitalized by simple two- and three-level hysteresis comparators. An optimum switching
table is then used to determine the status of three switches S1, S2, S3 and the corresponding voltage space vector vi depending on the stator flux region (θs). The stator flux position (θs) is determined by dividing the d-q plane into six 60 degree regions. Simple three sign detectors are used to determine the sector where the stator flux exists.

**Power Converter**

The space vector PWM technique is used to generate the firing pulses to the power converter. The SVPWM method is an advanced, computation intensive and the best among all PWM techniques for variable frequency drive applications. It is finding widespread applications in recent years because of the advantages it offers in its performance. The Space Vector based modulation technique is a digital technique in which the objective is to generate PWM load line voltages whose value is equal to the command voltage. This is implemented in each sampling period by selecting the appropriate switching states from the valid states of the space vector diagram. After proper calculation of the duration of the states, they are switched in proper sequence.

**SPACE VECTOR TRANSFORMATION**

The space vector transformation can be represented by

\[
\begin{bmatrix}
V_{an} \\
V_{bn} \\
V_{cn}
\end{bmatrix}
= 
\begin{bmatrix}
2/3 & -1/3 & -1/3 \\
-1/3 & 2/3 & -1/3 \\
-1/3 & -1/3 & 2/3
\end{bmatrix}
\begin{bmatrix}
V_{αo} \\
V_{βo} \\
V_{γo}
\end{bmatrix}
\]

Now in order to apply the space vector modulation, the three phase voltages are transformed into a diphase frame (α,β) using Concordia Transformation, thereby the time varying three phase variables become time invariant vectors.

*Figure 1. Block diagram of direct torque control*