Guest Editorial

RESEARCH in the area of speed-sensorless induction-motor drives has been of continuing interest during the past three decades. Thirty years can be seen as a long time span for a novel technology to develop. It is therefore all the more remarkable that standardized solutions have obviously not yet emerged, indicating that the maturing process of this important technology still continues.

Controlled induction motor drives without speed sensor have many technological and economic attractions. Reduced hardware complexity and lower cost are the most prominent, followed by the reduced size of the drive machine, the elimination of the sensor cable, better noise immunity, increased reliability, and less maintenance requirements. The operation in hostile environments often makes using a motor without speed sensor mandatory.

Early publications on sensorless control of induction machines date back to 1975. Reference [1] describes a constant volts-per-hertz scheme that uses a slip estimator to derive the mechanical angular velocity from a known stator frequency signal. In 1983, a vector-controlled drive operating without a speed sensor was presented [2]. In the following two decades, a large variety of sensorless control methods for induction motor drives have emerged, differing substantially with respect to the respective approach [3].

The advantage of eliminating the speed sensor as a delicate mechanical component has been a strong motivation to develop sensorless induction motor drives for many industrial applications. Constant volts-per-hertz schemes have gained a substantial market share owing to their robustness and simplicity. Techniques employing the principle of vector control satisfy the requirement of high dynamic performance. They enable drive control at a dynamic bandwidth equivalent to that of a sensored drive.

Differences do exist as regards low-speed performance. The estimation of rotor speed—and of the field angle in vector-controlled applications—relies on the effect of rotor-induced voltages on the stator currents. The magnitude of the induced voltages reduces as the electrical angular velocity reduces. Noise and parameter errors then become dominant, which impairs the accuracy of model-based estimation methods.

An alternative approach to achieve stable and accurate low-speed operation exploits the anisotropic properties of the machine. The angular position of the machine rotor, or, owing to local saturation effects, the spatial orientation of the magnetic field, can be traced by subjecting the machine to transient conditions and recording its response. Perpetual transients are stimulated by injecting additional harmonic voltage components at frequencies other than the fundamental. Also the response to pulsewidth-modulation (PMW) switching transients carries information on the orientation of machine anisotropies. It is an advantage of the latter method that it is inherently parameter independent, not counting the number of rotor bars per pole pair as required information. However, the separation between saturation-induced anisotropies and those that relate to existing rotor structures introduces additional problems. Employing such separation techniques enables also sensorless position control of an induction motor by locating rotor slot anisotropy.

Signal injection methods are not universally applicable to any machine. Open rotor slots or the existence of engineered rotor anisotropies is mandatory for rotor position estimation. Closed rotor slots favor the estimation of field angle.

The more important issue in sensorless operation of induction motor drives is achieving good dynamic performance, while achieving steady-state stability is not so much of a problem. Stable operation even at very low speed can be easily achieved at the expense of dynamic performance [4].

The current problems with sensorless control of induction motors relate mainly to achieving stability and fast dynamic response at lower speed, particularly around zero stator frequency, and simplicity of implementation. The authors of this special issue on sensorless control of induction machine drives have made noteworthy contributions to the advancement of this important technology.

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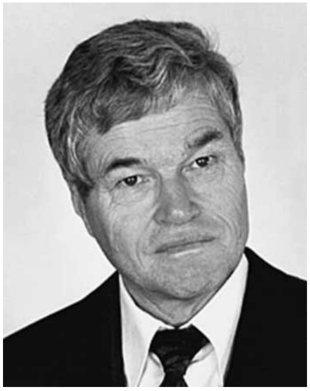

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