DOWNLOAD PDF FIELD ORIENTATION PRINCIPLE IN CONTROL OF INDUCTION MOTORS

Chapter 1 : Field Oriented Control of Induction Motor | Principle | Implementation

Induction motors, industrys traditional workhorses, are particularly well suited for FOP-based vector control. The Field Orientation Principle in Control of Induction Motors presents the FOP in a simple, easy-to-understand framework based on the space-vector dynamic model of the induction machine.

Field Oriented Control of Induction Motor: They are controlled in magnitude only. The stator current control does not take care of its phase position with respect to flux. The control does not provide satisfactory dynamic behaviour. There exists an oscillatory response to changes in the rotor frequency. The dynamic response may be improved using the principle of Field Oriented Control of Induction Motor where the stator current is controlled both in magnitude and phase position with respect to flux. In Field Oriented Control of Induction Motor drives the stator current has the function of providing flux as well as torque. The induction motor will have an operation similar to that of a de motor if the stator current components, namely flux producing and torque producing are separately controlled Fig. This is actually the case in a dc motor where the torque depends on armature current and the flux on field current. There is an inherent decoupling between them but for the effects of armature reaction. This kind of decoupling is being attempted in the control of induction motors. The principle is called field orientation or vector control. This control improves the dynamic performance of the drive at all speeds. The stator current is decomposed into two components one along the d-axis and the other along the q-axis. The reference axes have been chosen such that the rotor flux is available completely along the direct axis. Its quadrature component is zero. These are depicted in Fig. In the former the variation of flux is shown by varying direct axis component of current whereas in the latter the variation of q-axis component of stator current is depicted. Therefore the control of stator current amounts not only the variation of its magnitude but also its phase angle. The method is therefore called vector control. Techniques have been developed to keep the rotor flux constant. In these methods the torque follows without any delay, thereby improving the dynamic behaviour. Such a high quality dynamic behaviour is required for Field Oriented Control of Induction Motor used as actuators. The actual value of rotor flux is compared with the reference value and the error so obtained is used to control the direct axis component of current. Normally this component is Maintained constant so that the rotor flux is constant. The quadrature axis component is controlled using the error signal obtained from the comparison of actual torque and reference torque. The measurement is done by means of search coils , Hall probes or any other flux measuring techniques. The method is essentially insensitive to parameter variations. However, the cage motor loses its robustness and simplicity of construction. If one tries to retain the robustness and simplicity of the motor, the flux is obtained using the second method. The rotor flux is estimated from the stator voltage vector , current vector and rotor speed. This estimated flux is fed to the torque controller. Further, these parameters vary widely with saturation, temperature, frequency and current amplitude. The secondary flux level may be changed by the parameter variation. The methods identify the changes in the performance due to the variation of parameters and correct the parameters accordingly. The error between the estimated value of flux and desired flux in the motor is made use of to correct the most influential parameter, which is the rotor resistance or rotor time constant , so that the machine model gives the required value of flux without any error. Another method discussed recently is an on-line technique for establishing the exact value of rotor resistance of the induction motor. Identification is achieved by injecting a negative sequence current and detecting the negative sequence voltage. The value of the rotor resistance is calculated using the information. The Field Oriented Control of Induction Motor corrects the value of rotor resistance without the need for a thermal sensor.. The methods of state observer feed back are also employed for parameter identification. The flux vector can be very easily determined. Also, the elaborate process of field oriented control of the overall drive system has become economically feasible, as the expensive hardware used so far can now be substituted by software. As the PWM inverter has good dynamic behaviour, these are used with a current control on the output side. Induction motors in the flux weakening mode: In the case of dc motors speeds above base speed are obtained by decreasing the field current at constant rated armature voltage. The torque developed decreases. A constant power mode can be realised in this speed range and is called flux weakening mode. A similar behaviour can be observed in the case of induction motors. The voltage reaches its rated value for rated frequency. For frequencies above this value the inverter voltage is kept constant. The speed of the motor increases in proportion to the frequency. Due to the increase in the frequency, the air gap flux decreases. The torque at a given rotor frequency is inversely proportional to the square of the stator frequency and the power developed is not constant. The dynamic behaviour under weakened flux conditions is very poor. This can be improved by varying slip frequency for maximum torque in proportion to frequency. A motor having current feeding has a good dynamic behaviour when there is reserve voltage at the inverter terminals. When once a certain value of upper frequency is reached, the back emf of the motor is equal to. The actual value of stator current and rotor flux deviate from the desired values and the drive has a poor dynamic behaviour. Improvement of dynamic performance of the motor in the field weakening mode is a problem of interest. This can be done by controlling the amplitude of rotor flux and hence the back emf, so that sufficient voltage reserve is available in the speed range above base speed. Here also the direct and indirect methods of flux control can be used.

Chapter 2 : The Field Orientation Principle in Control of Induction Motors by Andrzej M. Trzynadlowski

ERRATA to the book "The Field Orientation Principle in Control of Induction Motors" by AM. Trzynadlowski Page xvii, 5th line from the bottom: replace "from" with "since".

They are extensively used in various applications ranging from industrial motion control systems to home appliances. However, the use of induction motors at its highest efficiency is a challenging task because of their complex mathematical model and non-linear characteristic during saturation. These factors make the control of induction motor difficult and call for the use of a high performance control algorithms such as vector control. The scalar control method for induction motors generates oscillations on the produced torque. Hence to achieve better dynamic performance, a more superior control scheme is needed for Induction Motor. With the mathematical processing capabilities offered by the micro-controllers, digital signal processors and FGPA, advanced control strategies can be implemented to decouple the torque generation and the magnetization functions in an AC induction motor. Field Oriented Control describes the way in which the control of torque and speed are directly based on the electromagnetic state of the motor, similar to a DC motor. With decoupling between the stator current components magnetizing flux and torque , the torque producing component of the stator flux can be controlled independently. Decoupled control, at low speeds, the magnetization state of motor can be maintained at the appropriate level, and the torque can be controlled to regulate the speed. This control is based on projections that transform a three phase time and speed dependent system into a two coordinate d and q frame time invariant system. These transformations and projections lead to a structure similar to that of a DC machine control. FOC machines need two constants as input references: The three-phase voltages, currents and fluxes of AC-motors can be analyzed in terms of complex space vectors. If we take ia, ib, ic as instantaneous currents in the stator phases, then the stator current vector is defined as follow: Where, a, b, c are the axes of three phase system. This current space vector represents the three phase sinusoidal system. It needs to be transformed into a two time invariant coordinate system. This transformation can be divided into two steps: The transformation matrix is given below: If you consider the d axis aligned with the rotor flux, Figure 2 shows the relationship from the two reference frames for the current vector: The torque and flux components of the current vector are determined by the following equations: If you know the accurate rotor flux position then, by above equation, the d, q component can be easily calculated. At this instant, the torque can be controlled directly because flux component isd and torque component isq are independent now. These measured currents are fed into the Clarke transformation block. These two components of the current enter into the Park transformation block that provide the current in the d, q reference frame. The isd and isq components are contrasted to the references: At this instant, the control structure has an advantage: In case of PMSM the rotor flux is fixed determined by the magnets so there is no need to create one. Therefore, while controlling a PMSM, isdref should be equal to zero. As induction motors need a rotor flux creation in order to operate, the flux reference must not be equal to zero. The outputs of the PI controllers are Vsdref and Vsqref. They are applied to the inverse Park transformation block. The outputs of this block provide signals that drive the inverter. Here both Park and inverse Park transformations need the rotor flux position. Hence rotor flux position is essence of FOC. The evaluation of the rotor flux position is different if we consider the synchronous or induction motor. In case of synchronous motor s , the rotor speed is equal to the rotor flux speed. Then rotor flux position is directly determined by position sensor or by integration of rotor speed. This method utilizes current model, which needs two equations of the induction motor model in d,q rotating reference frame. In DFOC strategy rotor flux vector is either measured by means of a flux sensor mounted in the air-gap or by using the voltage equations starting from the electrical machine parameters. But in case of IFOC rotor flux vector is estimated using the field oriented control equations current model requiring a rotor speed measurement. Among both schemes, IFOC is more commonly used because in closed-loop mode it can easily operate throughout the speed range from zero speed to high-speed field-weakening. Advantages of Field

Oriented Control Improved torque response. Torque control at low frequencies and low speed. Reduction in size of motor, cost and power consumption.

Chapter 3 : Field Oriented Control

*The Field Orientation Principle in Control of Induction Motors (Power Electronics and Power Systems) [Andrzej M. Trzynadlowski] on racedaydvl.com *FREE* shipping on qualifying offers. The Field Orientation Principle was fIrst formulated by Haase, in , and Blaschke, in* buy the ebook to support the author. Thank you for reading. Search a Book Search Recommended Books.

Chapter 4 : Vector control (motor) - Wikipedia

The Field Orientation Principle was fIrst formulated by Haase, in , and Blaschke, in At that time, their ideas seemed impractical because of the insufficient means of implementation. However, in the early eighties, technological advances in static power converters and microprocessor-based.

Chapter 5 : The field orientation principle in control of induction motors in SearchWorks catalog

It should be mentioned that the Field Orientation Principle can be used in control not only of induction (asynchronous) motors, but of all kinds of synchronous motors as well. Vector controlled drive systems with the soÂ- called brushless d. c. motors have found many applications in highÂ- performance drive systems, such as machine tools and industrial robots.