Abstract

Nowadays, several applications ask for some kind of synchronization between the different motors. Example because of the large output power required for the long production line, conveyor line or assembly line in the industrial producing process, a single motor can't achieve the required output torque. So in this situation, two or more motors are necessarily applied to complete the control tasks synchronously and coordinately.

The principle, on which this control scheme is based, is called the master slave motors control. The master motor is the reference motor to which one or more slave motors are synchronized. Its main characteristic is that the revolving speed output of the master motor will be the reference value of the slave motor. Any input signal or disturbance on the master motor can be reflected and followed by the slave motor.

The main objective of this research is to develop a mean of synchronizing two induction motors based on master-slave strategy, by designing a speed control system for the two induction motors. Mathematical model for the induction motor has been derived and tested using simulink in open-loop direct start-up mode, also a simulink model for PWM inverter.Vector control technique use PI controller has been used for both the master and slave motors.The simulation results obtained using simulink showed a better tracking performance with acceptable tracking error.

المستخلص

في الوقت الحاضر، هنالك عِدّة تطبيقات تحتاج لنوع من التزامن بين المحرّكاتِ المختلفةِ. على سبيل المثال بسبب قدرةِ الخرج الكبيرةِ المطلوبةُ لخَطِّ الإنتاجِ الطويلِ أو الخَطِّ الناقلِ أو خط التجميع في العمليةِ الإنتاجيةِ الصناعيةِ، نجد إن محرّكٍ واحدٍ لا يستطيع توفير عزم الخرج المطلوب. لذا في هذة الحالة، محركان أو أكثر تكون ضرورية لتكملة وانجاز عملية التحكم بشكل متزامناً ومتناسقاً.

هذا المبدأ، الذي يستند عليه مخططِ التحكم، يسمّى بتحكم السيد التابع للمحركات. إنّ المحرك السيدَ هو المحرك الاساسي بينما يكون هنالك محرك تابع أو أكثرِ من مطلوب مُزَامَنتها. الخاصيه الرئيسية هي أنّ السرعةِ الناتجة من المحركِ السيدِ تكُونُ هي الإشارةَ المرجعية للمحركِ التابعَ. أيّ إشارة دخل أو إضطراب على المحركِ السيدِ يُمْكِنُ عْكَسها وتتبعَها بواسطة المحركِ التابعَ.

إنّ الهدف الرئيسي للبحث هو تطوير وسيلة لمزامنة محركين حثيين اعتمادا على استراتيجية السيد التابع، من خلال تصميم نظام تحكم في سرعة محركين حثيين. النموذج الرياضي للمحرك الحثي تم إشتقاقه وإختباره بإستعمال simulink في الحلقة المفتوحة، أيضا نموذج عاكس تعديل عرض النبضة تم تمثيله بإستخدام simulink. إستعملت تقنية التحكم بالمتجهات بإستعمال متحكم تناسبي- تكاملي لكل من محرّكي السيد والتابع. نتائج المحاكاة التي تم الحصول عليها بإستعمال simulink واظهرت أداء تتبع جيد بخطأ مقبول.

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List of Symbols

d^e-q^e	Synchronously rotating reference frame direct and quadrature axes
d^s-q^s	Stationary reference frame direct and quadrature axes
f	Frequency (Hz)
I_m	RMS magnetizing current
I_r	RMS rotor current
I_s	RMS stator current
i_{dr}^s	d^s – axes rotor current
i_{ds}^s	d^s – axes stator current
i_{qr}	q^e – axes rotor current
i_{qs}	q^e – axes stator current
J	Moment of inertia (kg.m^2)
X_{ds}	d^e – axes synchronous reactance
X_{lr}	Rotor leakage reactance
X_{ls}	Stator leakage reactance
X_{qs}	q^e – axes synchronous reactance
θ_e	Angle of synchronously rotating frame
θ_r	Rotor angle
θ_{sl}	Slip angle
L_m	Magnetizing inductance
L_r	Rotor inductance
L_s	Stator inductance
L_{lr}	Rotor leakage inductance
L_{ls}	Stator leakage inductance
L_{dm}	d^e – axes magnetizing inductance
L_{qm}	q^e – axes magnetizing inductance
N_r	Rotor speed (RPM)
N_s	Synchronous speed
P	Number of poles
P_g	Air-gap power (watt)
P_m	Mechanical power
R_r	Rotor resistance (Ohm)
R_s	Stator resistance
S	Slip (per-unit)
T_e	Devolved torque (N.m)
T_L	Load torque
V_d	DC voltage (volt)
V_g	RMS air-gap voltage
V_m	Peak phase voltage
v_{dr}^s	d^s – axes rotor voltage
v_{ds}^s	d^s – axes stator voltage

V_{qr}	q^e – axes rotor voltage
V_{qs}	q^e – axes stator voltage
ϕ	Displacement power factor angle
ψ_a	Armature reaction flux linkage (weber.turn)
ψ_m	Peak air gap flux linkage
ψ_r	Rotor flux linkage
ψ_s	Stator flux linkage
ψ_{dr}^s	d^s – axes rotor flux linkage
ψ_{ds}^s	d^s – axes stator flux linkage
ψ_{qr}	q^e – axes rotor flux linkage
ψ_{qr}	q^e – axes stator flux linkage
ω_e	Stator or line frequency (r/s)
ω_m	Rotor mechanical speed
ω_r	Rotor electrical speed
ω_{sl}	Slip frequency
$\hat{X}$	Peak value of sinusoidal phasor or sinusoidal space vector (X any arbitrary variable)