ألاية

بسم الله الرحمن الرحيم

﴿٣٤﴾ ۞ ٱللَّهُ نُورُ ٱلسَّمَٰوَٰتِ وَٱلۡأَرۡضِۚ مَثَلُ
نُورِهِۦ كَمِشۡكَوٰةٖ فِيهَا مِصۡبَاحٌۖ ٱلۡمِصۡبَاحُ فِي زُجَاجَةٍۖ ٱلزُّجَاجَةُ
كَأَنَّهَا كَوۡكَبٞ دُرِّيّٞ يُوقَدُ مِن شَجَرَةٖ مُّبَٰرَكَةٖ زَيۡتُونَةٖ لَّا شَرۡقِيَّةٖ وَلَا
غَرۡبِيَّةٖ يَكَادُ زَيۡتُهَا يُضِيٓءُ وَلَوۡ لَمۡ تَمۡسَسۡهُ نَارٞۚ نُّورٌ عَلَىٰ نُورٖۗ
يَهۡدِي ٱللَّهُ لِنُورِهِۦ مَن يَشَآءُۚ وَيَضۡرِبُ ٱللَّهُ ٱلۡأَمۡثَٰلَ لِلنَّاسِۗ وَٱللَّهُ
بِكُلِّ شَيۡءٍ عَلِيمُۢ ﴿٣٥﴾

سورة النور

DEDICATION

To my family

ACKNOWLEDGMENT

In the name of Allah, Most Gracious, and Most Merciful

My deep appreciation and heartfelt gratitude goes to my supervisor, **Dr. Eisa Bashier Mohammed** for their constant guidance and the appreciable time he devoted to promote this work. It would have never been possible for us to work on this thesis without continuous encouragement.

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ABSTRAC

Power systems are subjected to low frequency disturbances that might cause loss of synchronism and an eventual breakdown of entire system. The oscillations, which are typically in the frequency range of 0.2 to 1.0 Hz, might be excited by the disturbances in the system or, in some cases, might even build up spontaneously. These oscillations limit the power transmission capability of a network. For this purpose, Conventional Power System Stabilizers (CPSS) are used to generate supplementary control signals for the excitation system in order to damp these low frequency power system oscillations. The use of power system stabilizers has become very common in operation of large electric power systems. The conventional PSS which uses lead-lag compensation, where gain settings designed for specific operating conditions, is giving poor performance under different loading conditions. The constantly changing nature of power system makes the design of CPSS a difficult task. Therefore, it is very difficult to design a stabilizer that could present good performance in all operating points of electric power systems. This thesis aims to propose a design of power system stabilizer based on model reference adaptive control to overcome drawback of conventional Power System Stabilizer. In this design, the existing controllers, designed using gradient descent algorithm and lyapunov method. The Adaptive Power System Stabilizer and Conventional Power System Stabilizer are evaluated on a single machine infinite bus system and three machines nine bus system by eigenvalue technique and time domain simulation using Matlab/Simulink. The simulation studies have been done to evaluate the effectiveness of the proposed control design. The results show that, the proposed adaptive power system stabilizer control scheme is able to stabilize power system oscillations under the changeable operation conditions than the Conventional Power System Stabilizer.

مستخلص

تتعرض أنظمة القدرة الكهربائية لاضطرابات التردد المنخفض والذي قد يؤدي الي فقدان التزامن ،وانهيار كامل للنظام .والتذبذبات والتي تكون عادة في مدي ٠.٢ الي ١ هيرتز قد تثيرها اضطرابات في النظام وفي الاحيان تبني تلقائيا .هذه التذبذبات تحد من امكانية الشبكة في نقل القدرة الكهربائية. لذا تستخدم منظمات التقليدية لنظام القدرة بغرض توليد اشارة تحكم ملحقة بنظام الاثارة لإخماد تذبذبات الترددات المنخفضة لنظام القدرة. استخدام المنظمات التقليدية لنظام القدرة اصبح معتاد لتشغيل أنظمة القدرة الكهربية الكبيرة .هذه المنظمات التقليدية عندما تستخدم تعويض التقدم – التأخر بضبط الكسب للعمل في ظروف تشغيل محددة ينتج عنه أداء سيء في ظروف تحميل مختلفة. طبيعة نظام القدرة المتغيرة بشكل ثابت تجعل تصميم منظمات التقليدية غاية في الصعوبة . لذا من الصعوبة بمكان تصميم منظم يعطي اداء جيد في جميع نقاط تشغيل نظام القدرة .

تهدف هذه الرسالة الي تصميم منظم نظام قدرة تكيفي مستند علي سيطرة الاشارة المرجعية للتغلب علي قصور منظم القدرة التقليدي . الحواكم الحالية تم تصميمها باستخدام خوارزميه الانحدار التدريجي وطريقة ليبونوف. المنظم التكيفي والتقليدي تم تقييم اداء هما لماكينة احادية موصلة في قضيب لانهائي ومن ثم في نموذج ثلاث ماكينات تسعه قضبان وذلك باستخدام تقنية قيم - ايقن وتحليل الاشارة في المجال الزمني باستخدام برنامج الماتلاب/ سيمولنك. ثم عمل الدراسات البرمجية لتقييم فعالية تصميم التحكم المقترح . نتائج مخطط سيطرة المنظم التكيفي اوضحت انها قادرة علي تنظيم تذبذبات نظام القدرة تحت ظروف تشغيل متغيرة بعكس منظم نظام القدرة التقليدي.

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LIST OF SYMBOLS

ΔEfd		exciter output
K_1–K_6		Linearization model constant
ΔV_t		terminal voltage
e		space vector of EMF, V
e		instantaneous EMF, V
T_m		mechanical torque
f		frequency, Hz
Í		phasor of current, A
I		constant value of current (e.g., rms or peak), A
i		space vector of current, A
i		instantaneous current, A
J		mass moment of inertia, kgm^2
L		inductance, H
P		real power, W
E_d'		direct axis component of voltage behind transient reactance
E_q'		quadrature axis component of voltage behind transient reactance
R		resistance, Ω
S		apparent power, VA
δ		Rotor angle in radians
ω		Angular velocity of rotor
t		time, s
τ_{qo}'		quadrature axis open circuit time constant
τ_{do}'		direct axis open circuit time constant
V		constant value of voltage (e.g., rms or peak), V
v		instantaneous voltage, V
X		reactance, Ω
D		damping coefficient of synchronous machine
I_q		quadrature axis armature current
I_d		direct axis armature current
H		inertia constant of synchronous machine in sec

Te		electrical torque of synchronous machine
T		transformation
ζ		damping ratio
$\boldsymbol{\tau}$		time constant, s
P		participation matrix
θ		Adjustable parameter
ym(t)		Reference model output
y(t)		Plant output
e(t)		error
u(t)		Control signal
r(t)		Reference input signal
J(θ)		Cost function

LIST OF ABBREVIATIONS

AVR		Automatic voltage regulator
HVDC		High voltage direct current
LFO		Low frequency oscillations
PSS		power system stabilizer
CPSS		Conventional power system stabilizer
APSS		Adaptive power system stabilizer
SMIB		Single machine infinite bus
MIT		Massachusetts Institute of Technology
RLS		Recursive least squire
MRAS		Model Reference Adaptive System
PSO		Power system operation
LQR		Linear quadratic regulator
LMI		linear matrix inequalities
SPSS		Supervisory power system stabilizer
DAI		distributed artificial intelligence
STC		self-tuning adaptive controllers
MRAC		Model Reference Adaptive control
LTI		Linear time invariant
WSSC		Western System Coordinated Council