UNIVERSITI PUTRA MALAYSIA

SMALL SIGNAL OSCILLATORY INSTABILITY CONTROL OF POWER SYSTEM USING POSICAST CONTROLLER AND EVOLUTIONARY PROGRAMING

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By

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Oscillatory stability is a subcategory of Small Signal Stability (SSS) which is defined as the ability of power system to maintain synchronous operation under small disturbances. The oscillations usually are concerned with frequencies between 0.2 to 3 hertz. Modal analysis is being used for analysis of SSS. Different methods have been presented by the researchers for controlling SSS such as: using power system stabilizer, HVDC, FACTS devices, etc. what is not considered in different methods is that how the stabilizer or a controller should present their output to the system, regarding to the dominant mode?

The posicast controller aim is to mitigate the oscillations of lightly damped system. In this study for each oscillation mode that is concerned with oscillatory instability, a posicast is designed, tuned and placed at the output of the power system stabilizer (PSS). In this case the electrical torque which is produced by PSS will go through the posicast first which will give the signal a manner in a way that it does not excite the dominant mode in advance while keeping its effectiveness for the system. Also a compensator is needed to reduce the steady state disturbances of the posicast. The gain of this compensator is very important because, by optimizing it the performance of the posicast controller is improved.

Two methods of optimization which are Evolutionary Programming (EP) and Genetic Algorithm (GA) were used to find the best value of the K and their comparative study were analyzed. Initially, to demonstrate the effect of the posicast controller the IEEE 9-bus test system was used. Then, the overall effects of the posicast controller and the optimization methods (EP and GA) were implemented on two different test systems i.e. The IEEE 39-bus test system and the 16-machine, 68-bus, 5-area test system.

For each case, first of all, the whole system is analyzed. Then, for the most sensitive modes the posicast is tuned and designed. A system consists of eigenvalue, posicast and compensator is then designed and used as a

fitness function of the EP and the GA to find the maximum acceptable value of the gain. In all three cases the posicast controller shows its positive effect to the total response of the system in case of disturbances.

The comparison between them shows that both of them reach to results which are almost the same. However, the choice between these two depends on the expectations and the hardware limitations.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah master sains

ISYARAT KECIL KETIDAKSTABILAN AYUNAN SISTEM KAWALAN KUASA KECIL MENGGUNAKAN PENGAWAL POSICAST DAN PROGRAM EVOLUSI

Oleh

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Kestabilan ayunan adalah subkategori Kestabilan Isyarat Kecil (SSS) yang ditakrifkan sebagai keupayaan sistem kuasa untuk mengekalkan operasi segerak di bawah gangguan kecil. Ayunan biasanya dibekalkan dengan frekuensi antara analisis 0.2 ke 3 hertz. Analisis Modal digunakan untuk analisis SSS. Pelbagai cara telah digunakan untuk menganalisis SSS diantaranya ialah : menggunakan sistem kuasa kestabilan, HVDC, pengesan FACTS, dan lain-lain apa yang tidak dipertimbangkan dalam kaedah yang berbeza ialah bagaimana penstabil atau pengawal hendaklah mengemukakan keluaran mereka kepada sistem, mengenai ke mod dominan?

Posicast pengawal bertujuan untuk mengurangkan ayunan sistem ringan teredam. Dalam kajian ini untuk setiap mod ayunan yang berkaitan dengan ketidakstabilan ayunan, posicast yang direka, ditala dan diletakkan pada keluaran penstabil sistem kuasa (PSS). Dalam kes ini tork elektrik yang dihasilkan oleh PSS akan melalui posicast pertama yang akan memberi isyarat dengan cara yang ia tidak membangkitkan mod dominan terlebih dahulu sambil mengekalkan keberkesanan terhadap sistem. Juga pemampas yang diperlukan untuk mengurangkan gangguan keadaan mantap posicast itu. Gandaan pemampas ini adalah sangat penting kerana, dengan mengoptimumkan ia, prestasi pengawal posicast akan bertambah baik.

Dua kaedah pengoptimuman Pengaturcaraan Evolusi (EP) dan Algoritma Genetik (GA) telah digunakan untuk mencari nilai yang terbaik untuk K dan kajian perbandingan mereka telah dianalisis. Pada mulanya, untuk menunjukkan kesan pengawal posicast IEEE 9-bas sistem ujian telah digunakan. Kemudian, kesan keseluruhan pengawal posicast dan kaedah pengoptimuman (EP dan GA) telah dilaksanakan pada dua sistem ujian yang

berbeza iaitu IEEE 39-bas sistem ujian dan 16-mesin, 68-bas dan sistem ujian 5-kawasan.Bagi setiap kes, pertama sekali, keseluruhan sistem dianalisis. maka, untuk kaedah yang paling sensitif posicast ditala dan direka. Sistem terdiri daripada nilai eigen, posicast dan pemampas kemudiannya direka dan digunakan sebagai fungsi kecergasan EP dan GA untuk mencari nilai maksimum yang boleh diterima daripada keuntungan. Dalam ketiga-tiga kes pengawal posicast menunjukkan kesan positif kepada keseluruhan tindak balas sistem dalam kes gangguan.

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I certify that a Thesis Examination Committee has met on 24 January 2014 to conduct the final examination of Shojaeddin Mirfendereski on his thesis entitled " Small Signal Oscillatory Instability Control of Power System using Posicast Controller and Evolutionary Programing" in accordance with the University and University Colleges Act 1971 and the Constitution of the University Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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