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THE ASSESSMENT AND IMPROVEMENT OF ANGLE STABILITY CONDITION OF THE POWER SYSTEM USING PARTICLE SWARM OPTIMIZATION (PSO) TECHNIQUE

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ABSTRACT

This thesis presents the assessment and improvement of stability domains for the angle stability condition of the power system using particle swarm optimization (PSO) technique. An efficient optimization method using PSO for synchronizing torque coefficients K_s and damping torque coefficients K_d to solve angle stability problems was developed and used to identify the angle stability condition on single and multi machine system. In order to accelerate the determination of angle stability, particle swarm optimization (PSO) is proposed to be implemented in this study. The application of the proposed algorithm has been justified as the most accurate with lower computation time as compared to other optimization techniques such as evolutionary programming (EP) and artificial immune system (AIS). Subsequently, a newly control technique named as proportional-integral-derivative (PID) incorporated with flexible AC transmission (FACTS) device is proposed in this study to improve the damping capability of the system. The minimum damping ratio ξ_{min} was applied as an indicator to precisely determine the angle stability condition based on PSO technique. The proposed optimization technique was compared with respect to EP and AIS. On the other hand, the installation of static var compensator (SVC) as the compensating device has been compared with respect to power system stabilizer (PSS) with lead-lag (LL) controller. PSS with LL controller (PSS-LL) system has been chosen due to well used by researchers of power system around the world and it can be selected as a benchmark model for research purposes. The study was implemented on single machine with infinite bus (SMIB) system. Results showed that the implementation of SVC as a compensating device managed to improve the angle stability condition. The application of SVC-PID was then extended with multi objective (MO) optimization process. The proposed approach was a combination of ξ_{min} and maximum damping factor σ_{max} as MO indicator in order to improve the damping capability of the system. The most suitable ratio of ξ_{min} and σ_{max} was investigated and applied into PSO based search algorithm. It was found that the proposed SVC-PID algorithm with MO as the objective function has been able to produce a better result as compared to the techniques developed in the literature.

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CHAPTER ONE
INTRODUCTION

Studies on prediction and improvement of low frequency electromechanical oscillation under small perturbations become more crucial recently, due to the rising incident of angle instability in power system worldwide [1-12, 19-26]. The identified factors related to this phenomenon are such as sudden increase in load due to the transmission line loss, increasing demand of electric power energy, the action of tap-changer of transformers and presence of disturbances. The operating conditions of the power system are change with time due to the dynamic nature, so it is needed to track the system stability online. To probe the stability of the power system conditions, efficient tools are needed in order to analyze and determine the condition in a short computation time. The stability condition of assessed system requires improvement. The system itself is incapable to elevate the stability condition, so introduction of simple and effective damping controller installed on the system will ensure the improvement of power system angle stability. Merging of various indicators into one multi objective indicator will escalate the assessment accuracy compared to single indicator.

1.1 PROBLEM STATEMENT

Small signal stability analysis under small perturbations is define as a study of the angle stability limits of synchronous machines resulted from poorly damped rotor oscillations [1-2]. Such disturbances that occur on the system will leads to certain limitation to the system loading capability. Studies on small signal stability receive major concern and were thoroughly discussed in [7-12, 18-25].

Angle stability analysis is one of the critical issues that need to be resolved to ensure a reliable power system operation. The angle stability analysis technique becomes so important, so that precise assessment on the system health can be studied in less computation time. Although several indicators or indexes have been proposed, it has long and complicated mathematical model. In addition, it also requires long