CHAPTER 7

CONCLUSION AND FUTURE SCOPES

The chapter presents discussion on results and summarizing the contribution of research work carried out by author. The limitations and assumptions are also described in this chapter. Directions for future research work are suggested.

7.1 Research contributions

The contributions of research are listed below.

- The software framework is designed to support inter-task communication between components using coordination object. The competitive or cooperative coordination mechanisms are used in situations in which a hard decision & soft decision has to be made between controllers respectively.
- The design method should deal with not only the control performance specifications but also the stability issues for process control systems.
- The design method should support the concurrently realizable ability in all development stages; the simultaneously deployable ability in various engineering domains and the synchronously deployable ability in multiple view.
- Design the new control performance assessment method using various control parameters as overshoot, steady state error, and variance in output, rise time, settling time, and Control effort.
- The Multiple model Adaptive controllers optimize using different soft computing techniques as neural network, fuzzy logic, Particle swarm optimization and genetic algorithms. The overall controller response must satisfy the plant objective

These contributions are discussed in more detail hereafter.

7.1.1 Controller performance assessment

- **Intelligent Control:**

R. Ramya and Dr.k.selvi [1] have presented a fuzzy logic PSS design to overcome the drawback of CPSS. Here mamdani method is used for fuzzification and centroid method is used for defuzzification. The system is subjected to three phase to ground fault shown by simulation. The comparison of output active power for system with CPSS, FPSS and without PSS has been done. The conclusion is that The FLPSS provide less settling time and thus the system become quickly stable than CPSS.

In the existing methods Fuzzy logic controller is designed with three membership functions whereas in proposed method seven membership functions were used for SMIB and multimachine system which conclude that the system is more stable compared to existing.

- **Smart Control:**

Dr. Jagdish Kumar and P. Pavan Kumar [2] have described a design of power system stabilizer based on ANN. The parameters of PSS are tuned by ANN. Two inputs active and reactive power are given to ANN. Here, feed forward neural network is used and trained by back propagation algorithm. Analysis shows that CPSS with fixed parameter settings can only provide good damping under some particular operating condition. But, the parameters are updated in real time by ANN, thus ANN- PSS provide good dynamic performance over a wide range of operating time and it take very less time to make the system stable.

The proposed method in the thesis gives parameter tuning of ANN for power system stabilizer. Here input for the PSS is taken as speed and observed the performances, also the no of hidden layer for the training of ANN is increased. This Smart control provides the satisfactory performance not only for single machine system but for multimachine system too. Also the real power is maintained in the system.

- **Controller Performance Comparisons**

The fuzzy logic based adaptive power system stabilizer is introduced along with the artificial neural network. Simulation result shows that for different operating conditions, the fuzzy logic power system stabilizer has increased the damping of the system causing it to settle back to steady state in much less time than the conventional power system stabilizer (CPSS) and it also decreases the peak value. The FLPSS, though rather basic in its control proves that it is indeed a good controller due to its simplicity. The proposed controller provides a more robust control over a large excursion of the operating points versus an optimal controller and lead-lag stabilizer. To overcome the drawbacks of conventional power system stabilizers, a fuzzy based power system stabilizer is presented. The proposed method is evaluated on a multi-machine power system and single machine system. FLPSS can provide good damping performance over a wide range of operating conditions. Such a nonlinear fuzzy based PSS will yield better and fast damping under small and large disturbances even with changes in system operating conditions. Better and fast damping means that generators can operate more close to their maximum generation capacity. Comparison between the fixed parameters FPSS and ANN along with CPSS shows that the fixed parameters ANNPSS has a better performance over a wide of operating conditions than the CPSS, and is less sensitive to change in operating conditions than CPSS, the parameters provides good transient and damping response even when the operating conditions changes.

7.1.2 Multiobjective Optimization

A.K.Ahouli and T. Guesmi [3] have proposed the design of GA based PSS for improving both transient stability and voltage regulation. Here, optimization problem is to minimize the power system oscillations after a disturbance and error is defined by speed deviation. GA works with coding of the parameters to be optimized. It employs search procedure for selection and finds the fittest solution to reach to the global optimum solution.

P.R.Gandhi and S.K.Joshi [4] have proposed the design of GA based PID-PSS and ANFIS- PSS for the improvement of system stability. Two different operating conditions are taken for analysis of response of rotor angle and rotor speed. Nonlinear analysis shows that system become quickly stable using ANFIS- PSS compared to GA- PSS and time response parameters are also improved by using ANFIS-PSS.

The designed method covers Multiobjective optimization considering online tuning of PSS for power system oscillation as well as minimizing the steady state error, overshoot, settling time, rise time, Integral of Absolute Error (IAE), Integral of Squared Error (ISE), Integral of Squared Time and Squared Error (ISTSE) by using genetic algorithm and particle swarm optimization methods. Also in [4] GA based PID-PSS was used instead the developed controller considers the GA base PSS which gives optimizes parameters values and minimizing the errors. Design of Genetic-Fuzzy controller for improving stability of generator for SMIB system. Here, for design of FLC, universe of discourse [-1, 1] is chosen and mamdani method is used for fuzzification. The scaling factor of fuzzy controller is optimized by GA. The result shows that the system oscillations are quickly damped using genetic fuzzy stabilizer compared to existing methods.

The simulation results of various parameter optimization techniques compared for both single machine and multimachine systems and its effectiveness is implemented. The performance of control is continuously assessed online with different parameters as steady state error, overshoot, settling time, rise time, Integral of Absolute Error (IAE), Integral of Squared Error (ISE), Integral of Squared Time and Squared Error (ISTSE) by using genetic algorithm and particle swarm optimization methods. The MOPSO is employed to search for optimal PSS parameters for a wide range of operating conditions. The effectiveness of the proposed approach in enhancing the dynamic stability of power systems is confirmed through Eigen value analysis and nonlinear simulation results. The performance of the proposed PSS for the optimization using Genetic algorithm & Particle swarm optimization. The ability to jump out the local optima, the convergence precision and speed are remarkably enhanced and thus the high precision and efficiency are achieved.It is found that the dynamic performance with the PSO based PSS shows improved results, over conventionally tuned GA based PSS over a wide range of operating conditions considering ‘Ts’,‘Tr’,‘IAE’,‘ISE’, ‘ITAE’ and ‘ITSE’ indices. It is shown that the proposed robust optimization provides good damping characteristics and enhances the dynamic stability of the system. Its level of robustness to system load variations is better than conventionally tuned PSS.

7.1.3 Real time implementation

In the Existing method shows that the processor in loop was created with ezdsp 2812 for the PSS. A DSP implementation of PSO for PSS controller tuning has been presented along with ezdsp 28335. This results in an elegant and compact self-tuning process as the PSS and the PSO algorithm are implemented on a single DSP. Utilizing the high processing speed of the DSP and the simplicity of PSO, the PSSs are successfully implemented in a real-time environment for tuning and testing. Classical optimal controllers can only be designed if the parameters of the system are known, while iterative tuning methods such as PSO can be applied to any system even if the system parameters are unknown. While the PSSs are tuned in real-time, a simulator was used to simulate the power-system. Because of the nature of power systems, online tuning of the PSS controllers is not possible. However, a DSP implementation of PSO for control could be adapted for online tuning if the system being controlled does not need to maintain optimal performance during tuning.

7.1.4 Design & Implementation of Robust MMAC

The fuzzy decision is implemented for the robust multiple model adaptive controller which select online the best control algorithm from conventional control, intelligent control & smart control. Different control parameters are considered for the input variable of the MMAC & return the output variable in the form of control techniques for single machine & multimachine system.

These contributions are discussed in more detail hereafter.

7.1.5 Overall conclusion

The robust MMAC for power system stabilization presented in this thesis which helps to achieve desired stability & security at a reasonable cost by modulating the generator excitation to provide additional damping to electromechanically oscillations of synchronous machine rotors. The robustness of the controller has been evaluated with respect to model uncertainties of the power generator. A comparative study of the proposed PSS with a conventional PSS with Fuzzy logic controller (Intelligent control), with ANN (Smart control), Multiobjective optimization using Genetic algorithm and Particle swarm optimization, Real time implementation with Processor in loop & Hardware in loop configuration with ezdsp28335 for SMIB & Multimachine system has been conducted.Effects of changing generator real power on the parameters of thepower system stabilizer are inspected. The dynamic performance of developed PSS is quite superior to that of conventional PSS for the loading condition differentfrom the nominal. Investigations also reveal that the performance is quite robust to a widevariation in loading condition.The design method of PSS yields better and fast damping under small and large disturbances even with changes in system operating conditions such as light loading, normal loading & heavy loading condition and also the transient stability is improved significantly. Better and fast damping means that generators can operate more close to their maximum generation capacity.

7.2 Future Scopes

It has been established that the proposed multiple model adaptive controller can be functionally useful, future work is required to understand the extent of this usefulness. Some suggestions in this regard are presented here.

- Robust Fuzzy PSS Design using Artificial Bee Colony (ABC) algorithm, A Robust PSS Automated Design Based on Advanced H2 and H∞ Frequency Control Techniques to Improve Power System Stability. Thus practical implementation of the above work is suggested.
- The design of controller by using Artificial neural network and fuzzy logiccontrol is presented. It is suggested to develop this controller by using ANFIS (Neuro-Fuzzy) in graphical based software environment for reducing the complexity & easily development.
- The Multiobjective optimization of PSS parameter online by using genetic algorithm and particle swarm optimization is implemented. So to maintain the stability online tuning by using Artificial Bee Colony (ABC) algorithm is suggested.
- A DSP implementation of PSO for PSS controller tuning has been presented. This results in an elegant and compact self-tuning process as the two PSSs and the PSO algorithm are implemented on a single DSP. The two PSO-tuned PSSs are shown to provide damping of power system oscillations.