5.1 Summary

Modified Repetitive controller has proven to be a simple and robust controller for DVR to maintain the quality of power input to a sensitive load. The dynamic voltage restorer with repetitive controller has compensated sag, unbalance, and harmonics by maintaining the voltage across assumed sensitive load close to the reference value.

The combination two power quality issues appearing together like; sag with unbalance, sag with harmonics, on the system is also successfully compensated by the DVR and its controller.

The same controller with a downstream fault current control scheme has controlled the downstream fault current that may have damaged the DVR, if not controlled. Thus it eliminates the need for separate fault current limiter.

The VHDL code for repetitive controller block is developed and verified through MODELSIM co-simulation with MATLAB.

The performance of the control system is improved by making it a missing Sensor Fault Tolerant Control System (MSFTCS). This system has detected and restored the missing sensor data sensor. Thus the input to the controller is least affected by a sensor failure and the quality of power input to a sensitive load is maintained by the dynamic voltage restorer.

The effectiveness of missing sensor data restoration system is verified through the simulation for the case of sensor failure when DVR is compensating some power quality issues.

The VHDL code for missing sensor restoration system block is developed and verified through MODELSIM co-simulation with MATLAB/SIMULINK.

5.2 Conclusion

The sensor fault detection and restoration system has improved the reliability, dependability and maintainability of the DVR as power quality conditioner. Since the control action is satisfactory in the event of sensor fault, the system becomes more
reliable. Also for same reason the system becomes more dependable for safety critical applications. As compare to traditional method of sensor fault tolerance system having number of string for same component, the proposed method requires less maintenance.

5.3 Contributions of the thesis

- The modified repetitive controller (both discrete and analog forms) for dynamic voltage restorer is simulated in MATLAB/SIMULINK to compensate various power quality issues in low voltage distribution system.
- The VHDL code for discrete time Repetitive controller is developed and verified through MODELSIM co-simulation with MATLAB/SIMULINK.
- Missing sensor detection system using Auto-associative neural network and a simple logic system is developed.
- The restoration system for detected missing sensor, using Particle Swarm Optimization (PSO) technique, is simulated in SIMULINK.
- The VHDL code for PSO block is verified through MODELSIM co-simulation with MATLAB/SIMULINK.

5.4 Scope for the future work

The proposed fault tolerant system concentrates on detection and restoration of sensor failure in the system. The other system faults like actuators can also be analyzed for further improving the reliability and availability of the control system.

The analysis of the sensor fault tolerant system when more than one sensor fails at a time can also be analyzed further with inclusion of some more objective function.

The verified VHDL code for the controller and missing sensor restoration system can be validated through experimental implementation in electrical distribution system.

The proposed modified repetitive controller can also be used with already installed DVR in power utility as a plug in controller with PI or PID controller to further improve the overall performance of the system.

This sensor fault detection and restoration system can also be added to any installed DVR (irrespective of the control system used) to make it missing sensor tolerant system.