Chapter 7

Conclusion and Future Scope

7.1 Conclusion

This work presents modified particle optimization (MPSO), modified whale optimization (MWO) and modified grey wolf optimization (MGWO) for harmonic minimization of hybrid cascaded multilevel inverter (HC-MLI) using SHE-PWM. The results obtained through MPSO, MWO and MGWO are compared in terms of harmonic minimization in HC-MLI as compared to genetic algorithm (GA), particle swarm optimization (PSO), whale optimization (WO) and grey wolf optimization (GWO).

It has been observed that at higher number of output voltage levels, the number of active and passive components are very high in HC-MLI and complicated voltage balancing mechanism is required in them, which makes the overall system bulkier and complex. The problem can be reduced using switched capacitor based MLIs (SC-MLIs), where the number of active and passive components are less as compared to HC-MLI. In SC-MLIs, the capacitors are self-balanced, and therefore the switching scheme is simplified. Two new topologies of SC-MLI, named as diode assisted switched-capacitor MLI (DASC-MLI) and reduced voltage stress switched capacitor MLI (RVSC-MLI) are proposed in this work using MGWO, wherein the number of active and passive components are further reduced. Moreover, the peak inverse voltage (PIV) and total standing voltage (TSV) are also reduced in DASC-MLI and RVSC-MLI as compared to reported SC-MLIs.

In chapter 2, an MPSO optimized three-phase, 11-level HC-MLI using SHE-PWM technique is explored. Improvements in weight and velocity features in MPSO take care of local optima efficiently, leading to better convergence rate and lower harmonic content as compared to GA and PSO. The proposed MPSO optimized HC-MLI ensures capacitor voltage balance, even at higher modulation indices by utilizing the available redundancies of HC-MLI. The capacitor voltage balance in HC-MLI is also achieved at higher modulation indices using harmonic injection method in this work. In chapter 3, MWO optimized three-phase, 11-level HC-MLI is presented. The adaptive position co-efficient vector and exponentially decaying function in MWO gives improved results as compared to conventional WO. In MWO, the chaotic local search technique efficiently takes care of possible local optima and enhances its convergence rate. Moreover, the proposed MWO balances the capacitor voltage even at higher modulation indices, exploiting the redundancies of HC-MLI. In chapter 4, MGWO optimized SHE-PWM has been used for harmonic minimization in HC-MLI. The use of adaptive position co-efficient vector and exponentially decaying function gives improved results as compared to GWO in MGWO. The chaotic local search technique in MGWO avoids local optima stagnation, while weighted position method enhances the convergence rate**.** The MGWO reaches global optima faster than other reported algorithms discussed in this work and effectively eliminates selected lower order harmonics from the output voltage. Some of the applications of the proposed work are medium and high-power motor drives, static synchronous compensators and active power filters. The work has been validated though theoretical findings and simulations. A 1.5-kW prototype is developed to demonstrate the steady state and dynamic performance of the proposed MPSO, MWO and MGWO optimized three-phase HC-MLIs.

Two new topologies of SC-MLIs, 17-level DASC-MLI and RVSC-MLI using reduced active and passive components are presented in chapters 5 and 6. The basic unit of DASC-MLI and RVSC-MLI require only one DC voltage source to generate output voltage levels using lesser number of active and passive components as compared to existing SC-MLIs. Also, TSV and PIV of DASC-MLI and RVSC-MLI are reduced as compared to reported SC-MLIs. Also, they have improved reverse current carrying capability as compared to existing SC-MLIs. Higher output voltage levels than 17-level can also be achieved using extended structure of DASC-MLI and RVSC-MLI. Capacitor voltage balance has been achieved without using any additional circuit in DASC-MLI and RVSC-MLI. The proposed circuits have been verified through extensive simulation and scale down experimentation.

7.2 Future Scope

- Other reported advanced PWM techniques (other than SHE-PWM) such as selective harmonic mitigation PWM (SHM-PWM) and selective harmonic elimination pulse amplitude modulation (SHE-PAM) can also be applied to the proposed MPSO, MWO and MGWO optimized HC-MLI to further reduce the harmonics in the output voltage waveform.
- SHM-PWM and SHE-PAM methods can also be explored in DASC-MLI and RVSC-MLI.
- Advanced digital processors such as field programmable gate array (FPGA), real-time laboratory (RT-LAB), dSPACE, etc. can be used to in place of DSP to achieve improved results.
- Applications of proposed HC-MLI, DASC-MLI and RVSC-MLI can be investigated in the area of renewable energy.

- Grid integration of proposed MLIs is another area which can also investigated. During grid integration modes, the power quality issues are required to be addressed by designing efficient switching techniques and robust controllers.