CHAPTER 9

CONCLUSION AND FUTURE WORK

9.1 CONCLUSION

This research work has investigated the output voltage characteristics of multilevel inverters under open-switch and short-switch fault condition in order to develop a better diagnostic tool to identify the failure of power electronic switches. Experimental and simulation results are reported on five level cascaded H-Bridge multilevel inverter at both open-switch and short-switch fault conditions. Salient features from the output voltage signals at different open circuit and short circuit fault conditions are extracted using FFT technique and DWT MRA technique. In addition, RMS value of output voltage and two different voltage ratios are evaluated at different fault conditions. Then extracted features are given as an input to various soft computing techniques such as ANN and ANFIS. Based on this, three different fault diagnostic methodologies are proposed in this work such as DWT-ANN approach, FFT-ANFIS approach and DWT-ANFIS approach. From the results obtained in this work, the following major conclusions are derived,

- When compared with load current pattern, it is observed that output voltage waveform at different fault conditions shows distinguished patterns and it is easy to understand the nature of fault from the visual inspection.

- Features extracted from the FFT analysis such as THD, 3rd Harmonic/Fundamental ratio and 5th Harmonic/Fundamental ratio provides valuable information about the faulty switch of the multilevel inverter.
- Energy content of the output voltage waveform at different level of decomposition of DWT MRA technique shows distinguished patterns for each fault case.
- Voltage ratio analysis also provides additional information for classification of fault conditions.
- Variations in the two voltage ratios (Vrms/Vdc and Vrms/Vav) of the output voltage signal at different fault conditions shows the nature of fault of multilevel inverter.
- Fault diagnosis performance of DWT-ANFIS approach for all fault cases, from normal condition to various open-circuit and short -circuit switch fault conditions, is quite better when compared with FFT-ANFIS and DWT-ANN approaches. Almost 100% identification rate is observed in DWT-ANFIS approach.
- FFT-ANFIS approach took 300 iterations for training the network, whereas DWT-ANFIS approach took 800 iterations and DWT-ANN approach took 2800 iterations. While comparing the other two approaches, FFT-ANFIS approach took less number of iterations and hence the training process is faster in this approach. However, since the previously trained network is only used for fault diagnosis purpose, DWT-ANFIS network can be considered for real time applications.

- DWT-ANN approach is trained and tested with 11 inputs. It requires more number of inputs to achieve a considerable performance. Whereas FFT-ANFIS network and DWT-ANFIS network are trained and tested with 4 inputs. Hence the training time is reduced. In addition, structure of the network also becomes simple.
- When compared with DWT-ANFIS approach and FFT-ANFIS approach, DWT-ANFIS approach is trained and tested only with 4 inputs obtained from DWT approach. Hence no intermediate computations such as voltage ratio analysis is required for this approach. Without any additional inputs such as voltage ratios, the performance of the DWT-ANFIS approach is better when compared with other approaches.
- Advantage of the proposed technique is that DWT MRA feature extraction process leads to drastic reduction in the number of inputs of the neural network and makes it possible to identify the individual faulty switch of multilevel inverter accurately.
- Proposed system can be easily implemented in the recent advanced embedded systems and do not require any additional expensive hardware system.
- Reported results show that the failure of power electronic switches of multilevel inverters could be easily identified using this proposed approach.

9.2 SCOPE FOR FUTURE WORK

- Since the number of levels of multilevel inverters are increasing day by day for high power applications, the proposed system can be tested for 7 level and 9 level inverter system.
- The proposed diagnostic system and reconfiguration technique can be implemented for on-site real time applications using LabVIEW based data acquisition system and the reconfiguration technique.
- For real time applications, while capturing the output voltage signal, in order to remove the high frequency noises advanced digital filters can be designed and implemented.
- The transients observed in current signal during the open circuit or short circuit faults of multilevel inverter can be analyzed for 7 level and 9 level inverters and a diagnostic technique can be developed based on this information.