CHAPTER 8

CONCLUSION

8.1 CONCLUSION

Though the concept of BLDC motor was established in 1962, it attracted researchers only after the modern era of power electronics and computer aided electromagnetic design. It combines many of the desirable qualities of induction-motor drives and DC commutator motor drives. BLDC motor is rugged and simple in construction and economical compared with the DC commutator motor and the induction motor.

In the past, BLDC motor was usually driven by a hard-switching PWM inverter, which has low switching frequency, high switching loss, high EMI, high acoustic noise and low efficiency etc. To solve these problems of the hard-switching inverter, many soft-switching inverters have been designed in the recent past. Unfortunately, high device voltage stress, large dc link voltage ripples, complex control scheme and so on were noticed in these soft-switching inverters.

In this thesis, a novel soft-switching inverter for the PMBLDC motor is designed with controllers such as PI, fuzzy, hybrid fuzzy-PI, genetic based PI and adaptive neuro-fuzzy inference system based controllers, which can generate dc link voltage notches during chopping which minimize the drawbacks of existing soft-switching inverters.
The dynamic behavior of the BLDC drive system with conventional PI, fuzzy, hybrid fuzzy-PI, GA-PI and ANFIS controllers are presented and compared for torque and speed operation.

From the results of proposed inverter topology with intelligent controllers, it is observed that

- All the high switching frequency switches work under soft-switching condition,
- Freewheeling diodes are turned off under zero-current condition which greatly reduces the reverse recovery problem of the diodes,
- Voltage stress on all the switches is very low and it is not greater than the dc supply voltage,
- The switching acoustic noise is very much reduced as the switching frequency is as high as 20 kHz,
- $dv/dt$ and $di/dt$ are reduced significantly and as a result EMI is reduced,
- Very simple auxiliary switches control scheme is needed
- The normal operation of the proposed inverter is essentially the same as that of the hard-switching inverter except that auxiliary switches are included which provide zero-voltage and zero-current switching.

The performance of the BLDC motor is better when the hard-switching inverter is replaced by a soft-switching inverter. Further, the
performance of the soft-switching inverter with intelligent controllers are much better than ordinary soft-switching inverter.

The performance characteristics of conventional PI and hybrid intelligent controllers are compared in terms of delay time, rise time, peak time, percentage overshoot, settling time, starting torque and torque ripples. It is observed that the ANFIS controller gives much better dynamic response for the system than other controllers. Moreover the system provides low torque ripples, high starting torque, better transient response with negligible overshoot, smaller settling time and rise time. Matlab simulation is constructed for all the controllers and hardware implementation except ANFIS controller are implemented for BLDC motor drives. Results obtained by simulation study are validated by experimental study. Further both the simulation and experimental results validate the work with zero-voltage, zero-current switching and with improved dynamic response.

In order to validate the theoretical and simulation results, the inverter for the BLDC motor can be constructed using ANFIS based controller and tested experimentally with DSPACE DS1104 kit. With regards to the implementation of ANFIS based inverter for the experimental work it is found that it can be carried out using DSPACE DS1104 kit from Texas Instruments. If this DSP kit is available then it is possible to download the MATLAB model of ANFIS available in the computer directly into this kit.
for the controller and converter topologies. Further this huge financial investment on this experimental work is beyond the capacity of the individual research scholar at present.

Already it has been experimentally tested that the theoretical and simulation results obtained using PI, fuzzy, hybrid fuzzy-PI and GA-PI based controller gave excellent results for validation. On similar line, it is expected that the use of ANFIS will also give similar expected results to validate the theoretical and simulation results. Therefore, it is proposed that the experimental work using ANFIS to control the speed of the BLDC motor can be carried out in future work.

The performance difference among hard and soft switching may be better identified with bearing current and common mode voltages. In addition, line current harmonic spectrum and Total Harmonic Distortion (THD) may be obtained both in simulation and in experiment. Also, current peak and switching frequency may be taken for study. Further, optimization techniques such as PSO, Ant Colony Optimization (ACO) and Bacterial Forageing Algorithm (BFA) etc may also be used to control the soft-switching inverter.