CHAPTER 6 DISCUSSION OF RESULTS 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. Results of proposed method also compared with the existing results. Directions for future research work are suggested.

The main objective of this research work has been to study different sliding mode controller design approaches for motors and drives. The study was motivated by the need to provide high performance digital controllers for motors & drive systems. The research work has covered the following major segments: (a) Multirate output feedback based discrete time sliding mode control of dc motor position control. (b) Multi segment Sliding Mode controller of Induction motor drive (c) Pulse Width Modulation (PWM) based control algorithm for three phase VSI fed Induction motor drive system. (d) Sine Pulse Width Modulation (SPWM) based control algorithm for three phase VSI fed Induction motor drive.

Multirate output feedback based discrete time sliding mode control (DSMC) has been designed for position control of separately excited dc motor system. Multirate output feedback based approach uses different sampling rates for control input and the output. DSMC based position controller for motors & drives are more robust in the presence of parameter variations, torque disturbances and external disturbances compare to conventional controllers. The position controller has been designed for separately excited dc motor system using MATLAB software. Simulation study carried out on third order systems. Simulation results shows that Discrete sliding mode controller using Multirate output feedback (MROF) approach brings position control system error states of dc motor to zero from the initial conditions.

Chattering is the disadvantage of the sliding mode control approach, with the proper design of sliding surface and control law, it can be reduced. Artificial Intelligence Techniques are also useful for the sliding mode controller design to reduce the chattering. Multi segment Sliding Mode controller (MSMC) is designed for speed and position control of Induction motor drive using field oriented control approach for the trapezoidal speed profile. Three sliding surfaces defined for speed and one for position control of the system. Fuzzy logic and GA based Multi segment sliding mode controller also designed and tested for induction motor control systems. Simulation results verify the effectiveness of controller. The simulation results also validated using the prototype testing.

Simulation study carried out using Pulse width Modulation (PWM) approach for three phase voltage source inverter fed induction motor drive. PWM control algorithm is developed for voltage source inverter of 10KHz switching frequency, 600V dc input with 415V, three phase,50Hz output. MATLAB, real time workshop, ePWM and Code Composer studio version 3.3 are also used for real time code generation. This control algorithm implemented using DSP 320F28335 for VSI fed induction motor drive. Experimental results captured using high resolution DSO. Experiment results validate the software results. Result analysis of hardware and software results also performed.

Sinusoidal pulse width modulation (SPWM) based algorithm is developed in MATLAB SIMULINK for the simulation study. Discrete SPWM based MATLAB-SIMULINK algorithm is developed for generating real time code of TI DSP320F28335 processor. This control algorithm is tested on real time experimental setup of high frequency, three phase voltage source inverter fed induction motor drive. Comparison of hardware and software results validates the controller design. SMC based SPWM control algorithm is also developed and implemented on real time experimental setup.

[66 of chapter-4] employs DSP based sinusoidal PWM generation for three phase inverter with switching frequency 10KHz is shown for DSP 2812, the D.C. voltage input to the inverter is 115V and with delta connected RL load and the output voltage was measured while in the proposed VSI based Induction motor drive system using PWM & SPWM approach control signals were generated with high performance TMS 320F28335 DSP controller.

- The switching frequency is 10KHz and input to the inverter is 100V DC and with star connected induction motor load. The high resolution six PWM output were generated to drive IGBTs of three phase Voltage Source Inverter. High frequency drive signals were given to Inverter stack through ePWM modules and PWM isolator module with programmable dead band.
- Six IGBT (SKM150GB12V) are used for this experiment, the rise time with turn on delay and fall time with turn off delay of each IGBT is 290 nsec and 450 nsec respectively.
- The switching frequency is 10 KHz, therefore to reduce switching loss the dead band between two inverter arms were programmed up to 11.4micro sec for optimum performance which is clearly visible in Fig.5.4.

- The existing results produced by [66 of chapter-4] is also of 10KHz switching frequency therefore in extension of previous work, here in the proposed work the PWM and SPWM outputs are programmed for 6.9 %, 25.2%,50.2%,75.2% and 93.6 % duty cycle along with programmable dead bands.(Fig.A.28-A.32).
- THD and Creast factor for PWM output is also measured and verified with simulation output and hardware implementations (Table 5.2).
- For 85% peak duty cycle the dc input voltage variation was performed from 50V to 100V and peak to peak ac output voltage were measured from 97V to 192V for hardware setup and also verified with simulation output from 100V to 200V variations. These variations in the results are because of switching and conduction losses present due to switching circuits in the hardware implementation.

[52-55 of chapter-3] employs Incremental motion controller or multi segment sliding mode controller of synchronous reluctance motor, induction motor, permanent magnet synchronous motor and smart controller for synchronous reluctance motor servo drive specified with trapezoidal profile were shown and implemented using PC-based prototype system.

- In the proposed system multi segment sliding mode controller for induction motor drive is implemented using SIMULINK tool box of the MATLAB software.
- The proposed method includes design of constant acceleration, constant speed and constant deceleration segment. Desired control object to rotate the rotor 6π radian in 0.6sec with speed and position control for trapezoidal profile is obtained with the proposed Multi Segment sliding mode controller is shown in Fig.3.20 and Fig.3.21 respectively and validated with the existing results.
- Genetic Algorithm and fuzzy logic approach is also incorporated in the MSMC controller design for speed and position control. Results of speed and position control for MSMC and GA optimized Fuzzy based MSMC are shown in Fig.3.25 and Fig.3.26 respectively.
- The prototype testing of the MSMC controller is also performed using PIL Technique for DSP 320F28335 controller.

Future work in the area of controller design of motor & drive systems could be in digital design using Multi rate output feedback based discrete sliding mode controller approach and its implementation using high speed processors like DSPs. As there is availability of high speed more featured DSPs in the market.