Abstract:

Recently, the mechanical differential (MD) of vehicle has been replaced by electronic differential (ED) by means of electric motor. Electronic differential ensures dynamic and robust control of the vehicle behavior. The ED has been designed for an electrical vehicle (EV) based on IPMSM due to its some inherent advantageous features. The design of speed controller of an IPMSM mainly depends on its mathematical model. The mathematical model based speed controller has been developed without consideration of core loss. Practically, the performance of torque control is affected by the core loss. Hence, the core loss during the design of a control system should be considered to obtain precise torque as well as speed performance. Conventionally, the speed control strategy of IPMSM has been designed based on PI controller. The design and implementation procedure of PI controller are easier and the gains of it's have been chosen by trial and error method. But, the overshoot and steady-state error cannot be minimized and the controller is not robust under the variation of load disturbance. In this paper linear quadratic regulator (LQR) based speed control of IPMSM is designed and analysis to apply in ED of an EV. The overall system has been demonstrated by simulation studies which are performed by Matlab/Simulink software. The simulation results show that the tracking of reference speed of IPMSM including core loss is achievable without any overshoot and steady-state error by the proposed designed LQR based optimal speed control. Moreover, the designed controller is robust under the variation of load torque.

Keywords: Electronic differential, steering angle, slope angle, linear quadratic regulator, interior permanent magnet synchronous motor