

UNIVERSITY OF THE WITWATERSRAND

Abstract

School of Electrical and Information Engineering

Master of Science in Engineering

Lagrange Modelling and Control for a Linear DC Machine

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Modelling of electric machines is often a very challenging task due to the underlying electromagnetic fields. The nature of the magnetic field is that they are typically time varying and have operational issues such as saturation, hysteresis, nonlinearities and coupling etc. Further, attempts to shape the fields e.g. into sinusoidal waveforms, e.g. with salient poles are never perfect. Losses such as eddy current losses among others compound to the problem of accurately modelling the underlying electromagnetic interactions of an electric machine.

The goal of this research is to utilize a dynamic energy based modelling technique to circumvent a number of the electric machine modelling challenges. Lagrange analysis is proposed to demonstrate its two key challenges namely; dynamic energy balance via Lagrangian energy equations and follow on Euler-Lagrangian state analysis. Secondly input and instantaneous rate of dissipation Euler-Lagrange model formulation and analysis incorporates a degree of freedom analysis to perform the physical model order analysis. This Lagrangian analysis is to be demonstrated on modelling a linear DC machine controlled for various performance criteria such as speed control, current control and power control. Further proposed results and analysis are for a pair of linear DC machines one of which is a gravity fed generator whose aim is to electrically drive the tandem DC machine up a slope under various control criteria.

Overall the novelty of this work is in utilizing the Lagrangian analysis to model a linear DC machine and also to utilize the same analysis to reduce the model complexity by systematically reducing the model order.