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Deep Learning-based Robot Control using Recurrent Neural Networks (LSTM; GRU) and Adaptive Sliding Mode Control

Raj Patel[1], Meysar Zeinali[2], Kalpdrum Passi[3],
[1]Department of Mathematics & Computer Science, Laurentian University, Sudbury, Ontario, Canada
rpatel7@laurentian.ca
[2]School of Engineering, Laurentian University, Sudbury, Ontario, Canada
mzeinali@laurentian.ca
[3]Department of Mathematics & Computer Science, Laurentian University, Sudbury, Ontario, Canada
kpassi@cs.laurentian.ca

Abstract **-** A phenomenal increase in computational power made deep learning possible for real-time applications in recent years. Non-linearity, external disturbances, and robustness are significant challenges in robotics. To overcome these challenges, robust adaptive control is needed, which requires manipulator inverse dynamics. Deep Learning can be used to construct the inverse dynamic of a manipulator. In this paper, robust adaptive motion control is developed by effectively combining existing adaptive sliding mode controller (ASMC) with Recurrent Neural Network such as Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU). A supervised learning approach is applied to train the LSTM and GRU model, which replaced the inverse dynamic model of a manipulator in model-based control design. The LSTM-based inverse dynamic model constructed using input-output data obtained from a simulation of a dynamic model of the two-links robot. The deep-learning-based controller applied for trajectory tracking control, and the results of the proposed Deep Learning-based controller are compared in three different scenarios: ASMC only, LSTM or GRU only, and LSTM or GRU with ASMC (with and without disturbance) scenario. The primary strategy of designing a controller with LSTM or GRU is to get better generalization, accuracy enhancement, compensate for fast time-varying parameters and disturbances. The experimental results depict that without tuning parameters proposed controller performs satisfactorily on unknown trajectories and disturbances.

Keywords: Robot Learning Control, Deep Learning, Recurrent Neural Network, Long Short-Term Memory, Gated Recurrent Unit, Adaptive Sliding Mode Control