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Machine learning using PMU data to perform Eigenvalue prediction

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Abstract

A modern power system faces daily challenges due to changes in load and generation patterns. These changes contribute significantly to the secure operation of the electrical network and power system stability and small signal stability. The work presented extends and contributes to research in power system stability and focuses on the predicting inter-area low-frequency oscillations on the integrated power system. Previous work in this area has made use of load flow models and traditional machine learning techniques such as linear regression and support vector machines to predict disturbances. The introduction of synchrophasor technology through the use of Phasor Measurement Units (PMUs) has, amongst other benefits, contributed to the monitoring of low-frequency oscillations. However, high resolution time series data provided by the PMUs require advanced methods of analysis to achieve the prediction target. In the research presented, data from five different PMU devices on the Southern African power system is used to predict eigenvalue locations on the eigenvalue plane using a Recurrent Neural Network technique known as Long Short Term Memory (LSTM). It is shown that the LSTM algorithm can accurately predict a small signal stability disturbance using a preceding window length of 20 seconds before the actual event occurs. Eigenvalues are estimated from the measured PMU data using the Matrix Pencil Method of eigenvalue estimation. LSTM showed an 80% accuracy in predicting the eigenvalues on the eigenvalue plane. Recommended future work would be to investigate the use of PMU devices for power system inertia prediction and to further determine the location of the disturbance on the network.