



Model-Based Hookload Monitoring and Prediction at Drilling Rigs using Neural Networks and Forward-Selection Algorithm

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The use of neural networks and advanced machine learning techniques in the oil & gas industry is a growing trend in the market. Especially in drilling oil & gas wells, prediction and monitoring different drilling parameters is an essential task to prevent serious problems like “Kick”, “Lost Circulation” or “Stuck Pipe” among others. The hookload represents the weight load of the drill string at the crane hook. It is one of the most important parameters. During drilling the parameter “Weight on Bit” is controlled by the driller whereby the hookload is the only measure to monitor how much weight on bit is applied to the bit to generate the hole. Any changes in weight on bit will be directly reflected at the hookload. Furthermore any unwanted contact between the drill string and the wellbore - potentially leading to stuck pipe problem - will appear directly in the measurements of the hookload. Therefore comparison of the measured to the predicted hookload will not only give a clear idea on what is happening down-hole, it also enables the prediction of a number of important events that may cause problems in the borehole and yield in some – fortunately rare – cases in catastrophes like blow-outs.

Heuristic models using highly sophisticated neural networks were designed for the hookload prediction; the training data sets were prepared in cooperation with drilling experts. Sensor measurements as well as a set of derived feature channels were used as input to the models. The contents of the final data set can be separated into (1) features based on rig operation states, (2) real-time sensors features and (3) features based on physics. A combination of novel neural network architecture – the Completely Connected Perceptron and parallel learning techniques which avoid trapping into local error minima - was used for building the models. In addition automatic network growing algorithms and highly sophisticated stopping criterions offer robust and efficient estimation of the optimal network. A forward-selection algorithm was applied to the data to identify the relevant features necessary for the prediction/monitoring process. The results show that a very small set of features are required to obtain a prediction accuracy in the magnitude of about ± 3 tons, equivalent to about $\pm 1\%$ of the maximum hookload.