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Automatic Model Calibration for Drilling Automation

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Abstract:
Objectives/Scope: High fidelity hydraulic models are essential for proceeding to a high level of automation in drilling. Mathematical models can facilitate process understanding and problem detection, and determine appropriate actions in case of mismatch between model and data. Furthermore, calculations may replace measurements where and when the latter are not available, as normally occurring during connections or when instruments fail.
However, advanced hydraulic models rely on a large set of inputs, such as pipe and wellbore geometry, various tuning parameters and fluid properties. The models are therefore time-consuming and difficult to configure in the field, where third-party experts may be needed at each well, to properly initiate the automation system and adjust it during the drilling process.
Managed Pressure Drilling (MPD) is a widely deployed example of drilling automation. In MPD, hydraulic models are utilized to calculate downhole conditions and determine the requisite choke pressure, which is automatically adjusted.
We present a method for automatic configuration of key model parameters, simplifying the tedious job of setting up the model and ensuring that the automation system remain tuned to the well, even without onsite model tuning expertise.
Methods, Procedures, Process: The proposed scheme is based on a simple method for separating inaccuracies due to frictional pressure losses and to static mud weight. The search for optimal correction factors is based on a sequence of small oscillations of pump rate that can be applied during drilling without interrupting the operation.
A parallelisation architecture is applied on top of the calibration algorithm. A set of hydraulic model instances run in parallel, allowing for efficient testing of changes in input signals within ranges of uncertainty. A reduced set of the best model instances is obtained by selecting those that required least adjustments to match measurements.
Results, Observations, Conclusions: Computer simulations demonstrate how the proposed calibration scheme allow for automatic tuning of friction factor and density correction factor, giving accurate prediction of bottom hole pressure (BHP). The tuning scheme is run in combination with the proposed parallel architecture, demonstrating that correct values of unknown configuration parameters can be automatically determined.
Novel/Additive Information: The deployment of automation systems in drilling is hampered by the need for dedicated expert personnel to maintain systems that could have reduced the personnel needed on the rig. The proposed automated model tuning method contributes to removing this roadblock, aiming at making automation systems a more cost-efficient option for drilling operations.

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