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Practical Challenges to Consider for Model-Based Engineering in Drilling Automation

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Abstract

Model-based engineering has become more prevalent in the drilling industry over the last few decades. While there is great value in using models, a realistic understanding of the types of problems that can be solved with models, the associated cost, and limitations is critical. Understanding these challenges will help facilitate communication, planning, and collaboration. This paper describes some of the challenges to understanding and ultimately automating drilling processes using models.

Examples of models used to solve industry problems are torque and drag, stick slip, surge and swab, drillstring dynamics, and many more. Models may be data-driven, or physics based, steady state or dynamic, high fidelity or reduced order for execution speed and clarity. To learn from a high-fidelity model, data must be collected and fed to the model and parameters estimated to reproduce the behavior of interest. Often there is not enough data to be certain of the relevant dynamics either because of aliasing or sparse sensor placement. Models for control systems and automation must be controllable and observable which means that most of the high frequency dynamics which represent things like high frequency torsional oscillations and whirl are eliminated, high fidelity is not appropriate. Specifying model requirements and modifying existing models to meet those may require a significant effort which should be considered when planning projects.

The goal is to provide an overview of common use cases for models, and a general description of associated model requirements, to illustrate some of the challenges and costs involved in drilling automation. Processes involved in developing models for specific applications are not described in detail. Instead, the reader is referred to relevant literature.