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Automating Anti-Collision Calculations for Autonomous Drilling Systems

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Abstract

The complexity of calculation along with the high stakes of error has traditionally meant that efficient implementation of anti-collision procedures required an experienced operator at the drill site. This is not ideal, as the expertise is only truly needed in isolated high-leverage situations. With the advent of automated drilling systems, more expertise is being moved from the drill site into the office. A system is proposed capable of balancing the efficiency of automated systems while retaining the safety afforded by expert supervision. Changing the way collision avoidance is conducted enables the full realization of the benefits of autonomous drilling systems.

The varied nature of collision avoidance operations makes it unlikely that the entire process will be completely automated in the foreseeable future. Sawaryn, et. al. (2018) outline eight elements required for a successful collision avoidance system. These elements are analyzed for the extent to which they can be automated. Historically, wellbore collisions are caused by operational shortcomings rather than a failure of calculations. The ideal system design would minimize any delay to the drilling process by focusing human efforts on validating the operational processes prior to drilling while automation handles the routine collection of data and application of calculations during drilling.

An autonomous drilling system can safely and efficiently execute in a collision avoidance scenario with the supervision of a remote monitoring center and appropriate risk-based escalation rules. Remote experts ensure that operational setups are valid prior to the start of drilling and that escalation conditions are clearly outlined. Separation-based cost functions are used to enable the autonomous drilling system to proactively steer away from escalation events. Mechanisms are defined that automate updates to provisional wellbore trajectories based on the automatic validation of survey data, projection of future possible well paths, and execution of separation calculations against separation rules. At necessary intervals human review confirms definitive wellbore trajectories, survey programs, and convergence plans. This moves tasks that require heavy human involvement outside of the critical drilling workflow. At appropriate risk levels, escalation occurs to increase the immediacy of the supervision, up to and including a stop-drilling condition requiring full management of change.

As more autonomous drilling systems are introduced in dense drilling environments, there is an increasing need to harmonize the requirements of these systems with collision avoidance workflows. By leveraging the ability of automation to identify critical points in the process, it is possible to move expertise to remote centers without sacrificing efficiency. Effective use of computer-assisted well planning can enable quick approval an optimal way forward leaving the execution to the automated drilling system.