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GEOTHERMAL RISING CONFERENCE

Material Transition Detection in Drilling Using Data Analytics

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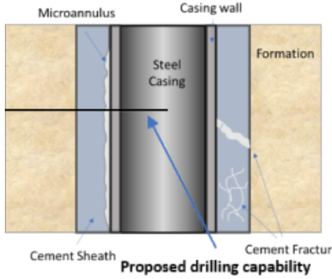
Abstract/Introduction

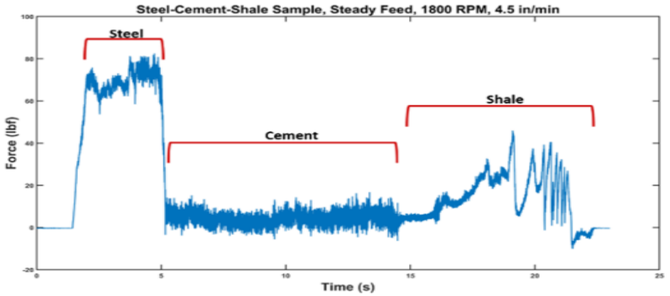
Wellbore Integrity is a large environmental and energy security problem for our nation. An estimated 30% of the 4 Million wells worldwide show signs of integrity failure. As a result, evaluation, characterization and remediation of wells has become a priority for industry, regulators and the public. This poster presents the work done towards the development of an autonomous, small-diameter, precise drilling real-time diagnostic tool to enable sensor emplacement for wellbore integrity monitoring. Using combinations of Mancos shale, cement, and steel to simulate the materials that are used in wellbores, drilling force data was collected and analyzed. This data shows there is a unique force signature for each given material. Temporal kurtosis was performed in order to detect rapid changes in the force data which would indicate whether the drill bit had transitioned into a new material in the wellbore. This post data collection analysis proved successful with obvious spikes in kurtosis observed at material transitions. The kurtosis analysis was then modified for real time analysis and integrated into the benchtop drilling software. With this integration kurtosis can be analyzed in real time and can be used to identify whether the drill is actively transitioning between materials. We hypothesize that a kurtosis value that varies far from a Gaussian distribution of 3 will indicate the drill is actively transitioning between materials. The ability to detect material transitions has far-reaching applications that extend beyond wellbore sensor emplacement. Potential applications include utilities installation and other access-limited drilling environments.



Proposed drilling capability

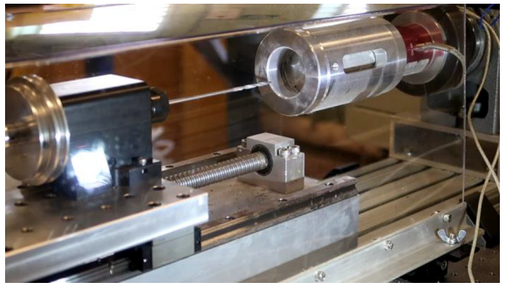
Objectives

- Simulate wellbore drilling using benchtop set-up and wellbore material sandwich samples
- Detect active material transitions while drilling using real time temporal kurtosis



Materials and Methods

Benchtop Test Set-up and Test Samples



- Carriage mounted spindle actuated using servo driven ball
- Bi-axial load cell coupled to test samples via test carrier—measures force and torque
- LabView data acquisition system
- Linear rail guides
- Position sensor

Test sample material "sandwich" used for microdrilling with material order of steel, cement, shale (variety of material orders were used)

Temporal Kurtosis

$$TK = \frac{\frac{1}{N}\sum_{i=1}^{N}(\mu_i - \mu)^4}{\left(\frac{1}{N}\sum_{i=1}^{N}(\mu_i - \mu)^2\right)^2}$$

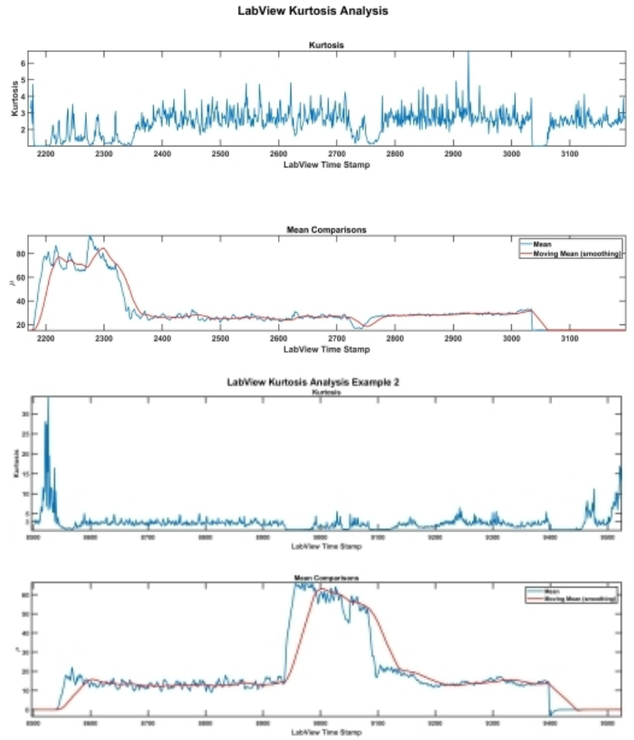
$$WHERE: \quad \mu = moving\ average \quad Window\ size = 512$$

LabVIEW

Results/Conclusions

- Each material has a unique force characteristic which can be used to determine which material is be drilled through
- A kurtosis value of around 3 is observed when drilling in a constant material
- When the drill actively transitions between materials a dip in the kurtosis value to around 1 is observed
- Kurtosis computation can be used in a real time capacity to determine active material transitions

Results Continued



Example for References

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