Digital Shaker Surveillance

Matt Bell, DrillDocs, addresses how computer vision can help offshore drillers avoid incidents and optimise performance.

Offshore drilling is a complex and unpredictable business. Success depends on gathering, integrating, and interpreting a range of direct and indirect signals to monitor equipment performance, hole cleaning, borehole stability, and well control. Issues in any of the four categories can lead to diminished drilling performance, lost time, remedial costs, and – in the worst case – serious risks to asset integrity and human safety.

An area of significant interest is the shale shaker, where the quantity, size, and shape of recovered solids can tell us a lot about what's going on downhole. And yet, the shakers are only monitored infrequently because they operate in a hazardous environment where crew access is restricted.

Computer vision technology, combined with advanced image analysis, offers an ideal solution. Using a camera, as an optical sensor, a shaker can be monitored and measured remotely and continuously without exposing rig crew to the hazardous environment.

In this article, we explore the challenges faced when developing a computer vision system for this application, some of the latest developments in digital shaker surveillance on offshore rigs, and how drilling operations might look in a few years' time, once digital shaker surveillance becomes standard practice.

What the shakers are saying

Drillers and operations geologists have always known that rock fragments emerging from the borehole have a lot to tell us about what is going on between the drill floor and the drill bit.

If the quantity of cuttings being collected is less than expected, they must be accumulating somewhere downhole and there's a risk of getting stuck. If the quantity is more than expected – or the size and shape of the rock pieces is that of cavings – the borehole is becoming unstable and might collapse.

The significance of this information was highlighted in a recent IOGP bulletin on pore pressure fracture gradient interpretation and uncertainty.[1] Among the Association's recommendations is real-time monitoring for "cavings and changes in caving morphology, size, or amount," and the report describes how the quantity and shape of cavings can be used to evaluate the risk of a kick or mud losses.

Figure 1. *Real-time data from the CleanSight system is delivered to the offshore and onshore drilling team via interactive dashboards.*

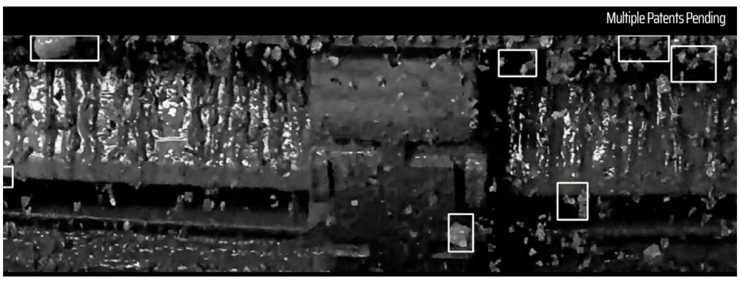

Figure 2. *CleanSight employs patented object detection algorithms to identify and characterise drill cuttings falling off the shale shaker.*

The size distribution of the cuttings can also help spot formation boundaries and when the drill bit crosses a fault.

Prior to tripping out of hole, it is best practice to circulate several hole volumes of clean drilling mud, sometimes augmented by high-viscosity slugs known as 'viscous pills' or 'sweeps' to help the cleaning process. When no further cuttings are observed at the shale shaker, the borehole is assumed to be clean.

The shakers are always speaking, but how often is anyone listening?

What the models are showing

Modern-day drilling relies on predictive models during well design and construction. A digital twin is created of the wellbore, based on best-available geological information and well-established drilling and borehole performance equations.

Although the processes of borehole creation (drilling), cleaning (cuttings transport), and stability (geomechanics) have not changed much since the 1880s, the equations we use to model them are still approximate. Several of the input parameters cannot easily be measured, especially in real time as the well is being drilled, which means predictive models are inherently inaccurate, often by ±20% or worse.

Drilling decisions are made by comparing what is being observed against what is expected, based on predictive models. Deviations must be analysed to decide what is causing the difference. Since several variables can be contributing, it is almost impossible to uniquely identify an underlying cause.

To improve the fidelity and accuracy of our models, we need new and better ways of measuring the inputs.

The promise of computer vision

Cameras monitor all sorts of industrial processes, especially in hazardous or inaccessible areas. However, the images must usually be interpreted by an expert before useful information is generated. Combining a high-resolution camera and computer-based image analysis is where the magic begins. Instead of relying on humans, an algorithm is trained to interpret images based on rules derived from human experience.

We see this all around us – at toll plazas, in parking lots, tracking packages, parts, and people around industrial workplaces, and alerting workers to unsafe conditions. We also understand its limitations. Autonomous vehicles are not yet mainstream, and self-driving cars still get involved in accidents. The complexity of the task determines how effectively and consistently computer vision can work.

At the shale shaker, several issues complicate image interpretation, including:

- Variable light levels, leading to under- or over-exposure of the image.
- Dust or moisture on the camera that obscures part of the image.
- Cuttings lying on top of one another, blocking the camera's view of some material.
- Observing irregular, tumbling, 3D objects with a camera that only sees in two dimensions.
- Very small cuttings, falling below the camera's effective resolution.
- Residual mud coating the cuttings, making their size and number difficult to measure.
- Overloading of the shakers, causing mud and cuttings to overflow.

An effective computer vision system for digital shaker monitoring must handle these challenges to deliver reliable and valuable data to the drilling team.

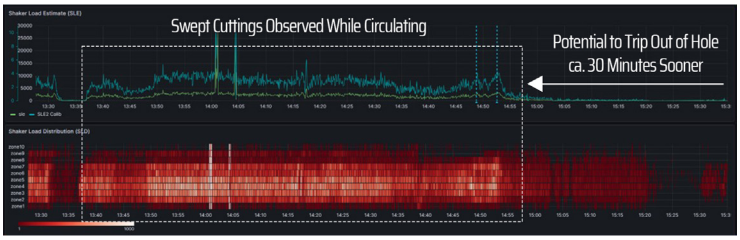

Figure 3. *Real-time surveillance allows tripping out of hole as soon as the shakers are clean, rather than waiting for a prescribed time or pumped volume.*

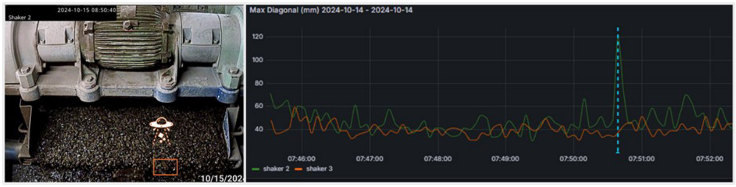

Figure 4. *Image of the industry first caving detected automatically by a computer vision system for AkerBP in October 2024.*

Bringing computer vision to the shale shaker

Early attempts at applying computer vision to shale shakers focused on the shaker bed. This was compromised by inconsistent cutting movement along the bed and changes in cuttings depth and mud coating.

More recently, DrillDocs, a Houston-based oil and gas tech startup, has developed and patented an approach that observes separated cuttings as they fall off the shaker table. This reduces the risk of imaging cuttings more than once, since their direction of travel becomes constant once they are falling under the singular influence of gravity.

A camera positioned in front of the shale shaker captures images within a window of interest spanning the full width of the shaker table and several inches above and below the table end. Edge computing built into the camera pre-processes the image, so that data transmission across the rig and to shore can be optimised. Image analysis routines are applied to:

- Extract relevant parts of the image.
- Enhance contrast and separate objects from the background. Discriminate objects such as cuttings, cavings, and UFOs (unidentified falling objects).
- Label and, where possible quantify object features, dimensions, and other parameters.
- Train and deploy a classification algorithm to match objects to wellbore events and conditions.
- Produce alerts and statistical outputs for real-time display and trend analysis.

Typical outputs from the image analysis are:

- Shaker load distribution (SLD), describing cuttings distribution across the shaker table.
- Shaker load estimate (SLE), providing a qualitative trend of shaker load.
- Shaker load actual (SLA), providing a calibrated estimate of cuttings return rate.
- Unidentified flowing object (UFO) detection, capturing images of unusually large objects and classifying them as cavings or other debris.

These outputs are displayed in real time on a touchscreen in the driller's console, the geologist's or drilling superintendent's office, the remote operations centre (if applicable), and via a web-based remote monitoring platform for other permitted team members.

Validating digital shaker surveillance

Before deploying the technology on an active rig, the team worked with the TUDRP consortium to compare image analysis results with calculations and physical measurements made at its experimental flow loop. The results were encouraging and led to further improvements in hardware and software.[2]

Next, a prototype system was deployed on a land rig operating for XTO in the Delaware Basin, in Texas.[3] Numerous issues were encountered with changes in natural lighting, mud and water splashing onto the camera, and loss of connectivity following rig moves. Nevertheless, qualitative and quantitative measurements of cuttings return rate were made, and successfully correlated with drilling operations – including connections, ROP changes, sweeps, and trips.

Moving offshore, an enhanced system was deployed on the Saipem Santorini, drilling for ENI offshore Egypt and Côte d'Ivoire. The results, which will be published at the Offshore Mediterranean Conference in April and the Offshore Technology Conference in May, prove that the system can be installed and operated on a drillship without interrupting regular operations. Two shakers were monitored while drilling approximately 10 000 m, across hole sizes ranging from 8.5 in. to 17.5 in., as well as five shoetrack drill-outs. A potential pack-off event was observed, and the effectiveness of several sweeps was monitored.

The system was next deployed on a jack-up rig drilling for Aker BP on the Norwegian Continental Shelf. Real-time cuttings data were delivered to rig personnel and the onshore Real-Time Operations Centre. This validated the technology and unlocked a second phase where object detection was used to observe unidentified falling objects (UFOs) to detect cavings. The results of this world-first accomplishment will be reported at the Offshore Drilling Conference in March.[4]

The technology is also being actively deployed for Exxon in Guyana as part of the company's real-time cuttings recovery initiative, comparing calibrated cuttings return rate from digital shaker surveillance with physical measurements on the rig. This high-profile project aims to significantly improve drilling efficiency and safety using edge computing and real-time measurements.

The value of digital shaker surveillance

Digital shaker surveillance promises to impact drilling efficiency and safety in numerous ways.

The first will be derisking drilling at higher rates of penetration, relying on real-time shaker measurements to confirm that hole cleaning can keep up with cuttings generation. As the DrillDocs team likes to say, "Drill Faster Without Disaster."

Next comes rig time savings from shorter circulating periods prior to tripping out of hole. With offshore spread rates reaching US$250 - 350/min., saving 30 minutes before each trip will save tens of thousands of dollars per well.

AI-enabled object classification will provide early warnings of potential borehole instability, loss of well control, or downhole equipment failure. Allowing the drilling team to quickly diagnose and react to a deteriorating situation will reduce the frequency at which events escalate into incidents. Avoiding a stuck pipe incident by recognising ahead of time that the borehole is beginning to collapse can save many hours – and millions of dollars.

Finally, the widespread deployment of digital shaker surveillance will produce digital archives on which to train machine learning models to spot patterns in shale shaker images and relate them to events logged in offset wells. In this way, computer vision and data science will truly begin to replicate – and potentially exceed – the human learning process.

Where computer vision takes us next

Ever improving camera and processing technology will drive steady increases in the resolution and accuracy of computer vision systems. This will lead to superior cuttings characterisation. Combined with a growing database of previously imaged cuttings, cavings, and other objects, this will enable faster and clearer guidance for the drilling team.

Bringing computer vision to the offshore rig requires a culture change. Drilling crews are proud people who don't like the idea of "Big Brother" watching them or of a computer taking over what has traditionally been a human's job. Digital shaker surveillance should avoid this issue by focusing on an area of the rig where the crew doesn't want to spend time monitoring a mundane process. As the data proves its worth, trust in the system will grow and become standard operating practice on high-performance offshore rigs.

Having established the efficacy of computer vision in the shaker room, we expect cameras will take on other tasks around the rig. For example, they could monitor other aspects of drilling mud management and observe for mechanical failures, incorrect equipment placement, or deficiencies in personal protective equipment.

The power of generative AI and large language models (LLM) is being explored throughout the industry. It will help transform digital shaker surveillance from a valuable cuttings measurement into an indispensable advisor supporting the wider process of drilling automation.

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