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USING A VISION SYSTEM TO ASSESS THE PHYSICAL CHARACTERISTICS OF A PETROLEUM RIGGING DRILL PIPE SEGMENT

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Using a Vision System to Assess the Physical Characteristics of a Petroleum Rigging Drill Pipe Segment

Abstract: A technique is disclosed that provides a real-time above-hole method of assessing the drill string dynamic behavior, and drill pipe segment physical characteristics, in petroleum drill rigging applications. A 3D imaging system assesses the wear and tear of each unique drill pipe segment, and allows the rejection of pipe segments prior to usage downhole

This disclosure relates to the field of petroleum drilling.

A technique is disclosed that provides a real-time above-hole method of assessing the drill string dynamic behavior, and drill pipe segment physical characteristics, in petroleum drill rigging applications, using 3D structured light imaging technologies.

Petroleum drilling is a costly endeavor. In 2018, the drilling costs in the United States ranges from $110 to $150 per foot. Needless to say, part breakage can easily result in hundreds of thousands of dollars in costs. For example, the round trip cost on a BHA assuming a well depth of 10K feet requires approximately 11 hours (to fish the drill string, and then trip the string back to depth).

There are number of types and causes of part failure. Pipe failure as a result of twistoff occurs when the induced shearing stress caused by high torque exceeds the pipe-material ultimate shear stress. This typically occurs in directional and extended-reach drilling, where torques in excess of 80,000 lbf-ft are common and easily can cause twistoff to improperly selected drillstring components. Pipe-parting failure occurs when the induced tensile stress exceeds the pipe-material ultimate tensile stress. This condition may arise when pipe sticking occurs and an overpull is applied in addition to the effective weight of suspended pipe in the hole above the stuck point. Pipe failure as a result of collapse or burst can occur under extreme conditions of high mud weight and complete loss of circulation. And pipe fatigue, a dynamic phenomenon that initiates microcracks and propagates them into macrocracks can occur as a result of repeated applications of stresses, causing fatigue failure.

Currently, drill pipes are assessed for a variety of conditions prior to usage, including the remaining wall thickness, the off-center wear of outside pipe surface, dents, collapse, necking, outside diameter enlargement or reduction, longitudinal notches and nicks, transverse notches, and all thickness under the deepest corrosion spot. These measurements may be performed visually, ultrasonically, magnetic particle/induction, and gamma ray. However, during pipe tripping by the rig crew, all inspections are performed visually. So, existing rig solutions are constrained to only visual inspection of the drill pipe.

According to the present disclosure, and as understood with reference to the Figure, in a drill pipe arrangement 10, a 3D imaging system 20 assesses the wear and tear of each unique pipe segment and allows the rejection of pipe segments prior to usage downhole. This prevents costly pipe breakage which would then require the crew to fish the bit, and re-load the drill string.

The structured light 3D imaging system 20 is provided within a robust IP67 casing. This imaging system has three IR structured light vision systems each arranged at 120 degrees. This structure 20 surrounds the drill pipe. The vision systems are protected with e.g. a Class 5 10mm gorilla glass surface. The surface of the glass is cleaned by a wiper system, water source, and air source.

As the pipe is moved past the system 20, its entire surface is recorded using the 3D vision system 20, and is associated with the ID serial number of that drill pipe. This allows the inspection of a pipe both prior to use and after use, allowing wear to be quantified.

This imaging system 20 may be placed in a variety of locations. With a top drive drilling system, it can be positioned above the platform 30 and the turntable 40, and swung away when the pipe clamp is in use. The drive string can be 3D-measured as pipes are removed from, and inserted into, the drill string. In a top drive system with adequate spacing, the assembly can alternatively be disposed below the turntable 40 and above the blowout preventer 50.

The imaging system 20 permits the scanning of each drill pipe segment prior to downhole insertion in order to quantify diameter variations, warp, and cracking. This information can be correlated to each unique drill pipe using either existing tags, or alternate serializing technology. During drilling, the out of round movement of pipe of the drill string (above the surface, but below the Kelly 60) is quantified, which may be indicative of a series of down-hole drill string problems. During tripping, the gap between each drill pipe segment is assessed. And each drill pipe segment is re-scanned during removal to quantify changes.

The disclosed technique advantageously provides a high resolution surface mapping of each drill pipe segment prior to and after its use. Depending upon positioning within the oil rig, it can perform this task without interaction from the oil rigging crew, and tracks each drill pipe by serial ID.

Based upon real-time results, this system can alert the crew that a particular pipe should not be used, but rather subjected to a more critical, off-line, evaluation.

Furthermore, in a top drive system, this vision system can also measure drillstring out of round / non centered placement. This information, in conjunction with downhole instrumentation, can provide a more complete understanding of the well behavior.

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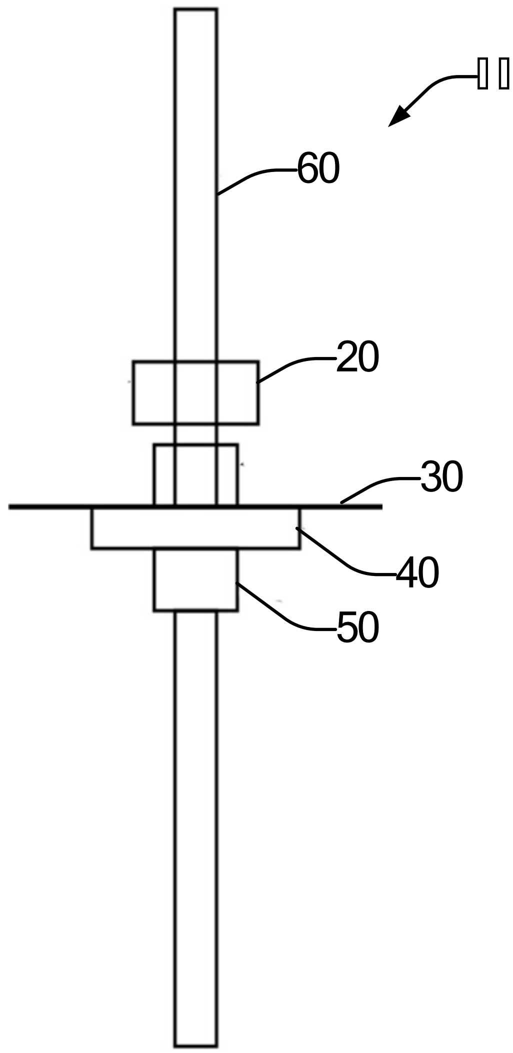
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