DSATS Drillbotics Competition Day

on June 4th, 2017 in Clausthal, Germany
Introduction

Team members 2017

Description design functionality
  - Hydraulic system
  - Hoist and feeding system
  - Top drive
  - BHA
  - Control interface

Lessons learned from the 2017 competition day

Current undertakings for next years competition
Institute of Petroleum Engineering

Head of Department: Professor Oppelt

- Drilling Technology
- Well Construction
- Wellbore Integrity
- OCTG Testing
- Production Technology
- Multiphase Transport
- Mature Fields Technology
- Drilling Fluids and Cement Laboratory
Team Members

- Erik Feldmann [team lead]
  - Petroleum engineering – drilling & production
- Wolfgang Hollstein
  - Mechanical engineering – automation technologies
- Dominik Orgel
  - Mechanical engineering – mechatronics
- Jana Huchtkötter
  - Computer Science

*Retired after Phase I: Alexandra O., Samuel Z.*
Hydraulic system

- Powered by 11 kW motor connected to a VFD
- Triplex piston pump with variable upstroke, max 0.33 l/s
- Max. Pressure: 120 bar
- Connected Sensors:
  - Flow switch
  - Pressure sensor: 0-160 bar
- Settling system with pre-charge pump for closed loop
Hoisting system

- Spindle driven by to stepper motor
- TR 24x4
- Connected Sensors:
  - DI Upper and lower inductive limit switch and homing sensor
  - Encoder
Top Drive

- 440W BLDC Motor with built in encoder
- Torque limiter (clutch)
- 2\textsuperscript{nd} Encoder to indicate speed difference
- Belt drive
  - Transmission ratio 1:4
- Hollow drive shaft for hydraulic system
- Connection of the drillpipe with a tapered clamping sleeve
BHA – Sensor Unit

- Microcontroller ESP8266
  - 160MHz, 64 kB RAM
  - I²C WIFI Websocket
- IMU LSM9DS1
  - 9 Degree of Freedom
    - Accelerometer, Gyro, Magnetometer
    - I²C
- Switchmode Powersupply
  - 1.5V to 3.3V
BHA – Hammer drill

- Stainless steel housing
- Bronze linear bearings
- First prototype drillbit with carbide inserts
BHA – Hammer drill
Control interface

- NI Labview
- For competition day
  - Reliable set point control of WOB was chosen due to time constraints instead of implementing specific energy equivalence for hammer drilling
Lessons learned

- Backpressure buildup for hammer is vital to start
- Delayed drilling start lead to loss of communication with downhole tool sensors
  - Reduce energy consumption of bottomhole assembly or integrate other means of power supply
- Higher impact energy and better control algorithm required to increase ROP
  - Improve hammer design efficiency and bit design
  - Implementation of specific energy algorithm for hammer drilling with inclusion of downhole data

**Additional new undertakings:**

- Realtime downhole torque and WOB measurements
- New communication setup
- Various mechanical improvements
Thank you for your attention!