DSATS Automated Drilling Competition

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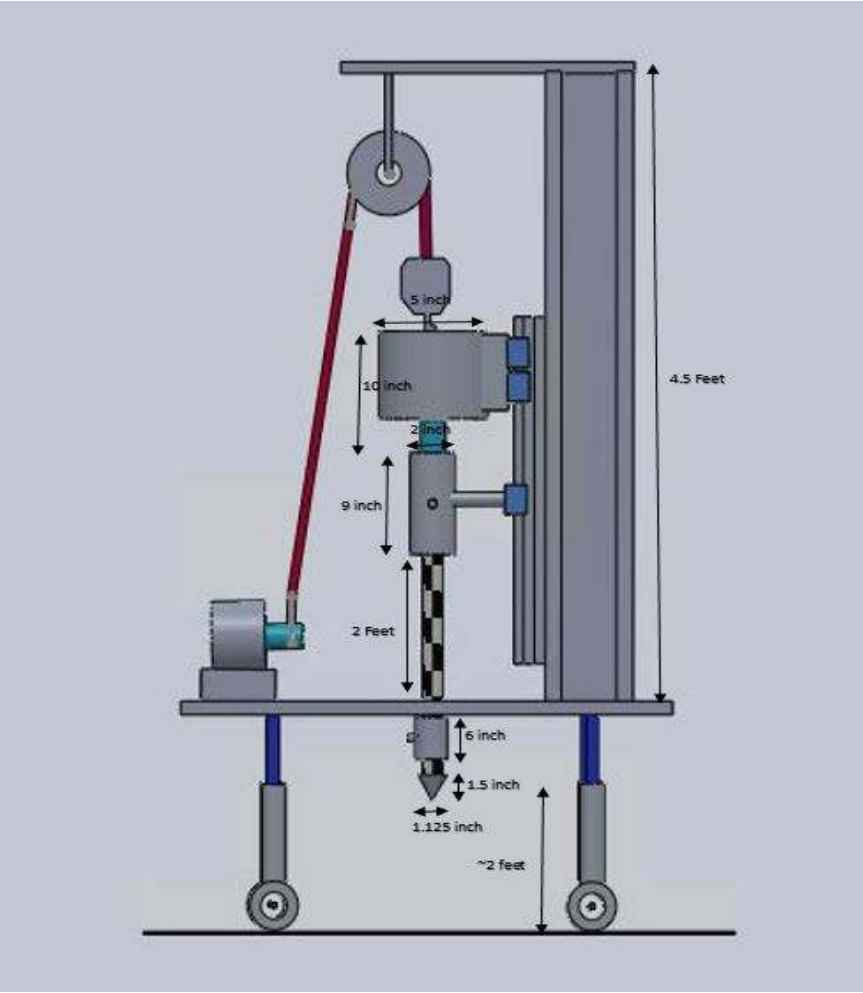
Outline

1. Drilling Rig Construction
2. Control System Design
3. Conclusion

Drilling Rig Construction



- Drilling rig with functionality of a mobile land rig
- Four Steel support pipes for mobility and stability
- Variable RPM Motor representing a Top Drive system
- Hoisting system to accurately measure and control the WOB with a Load Cell
- Close loop air circulation system with air as drilling fluid

Control System Design

- **<u>Dysfunctions</u> encountered down-hole**
  - Bit balling
  - Bottom-hole balling
  - Lateral Vibrations (Whirl)
  - Torsional Vibration (Stick-slip)
  - Axial Vibration
  - Interfacial Severity

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Control System Design

- **Control Algorithm**
  - Using Mechanical Specific Energy (MSE)
  - Basic Principle:
    1. Increase WOB until something limits you from doing so
    2. Make real time changes that extend the limiter (whether it is bit or non-bit)
    3. Redesign the system post-drill to extend the limiter
    4. Repeat 1-3

Source : Prof. Fred Dupriest Lecture notes on Bit Mechanics

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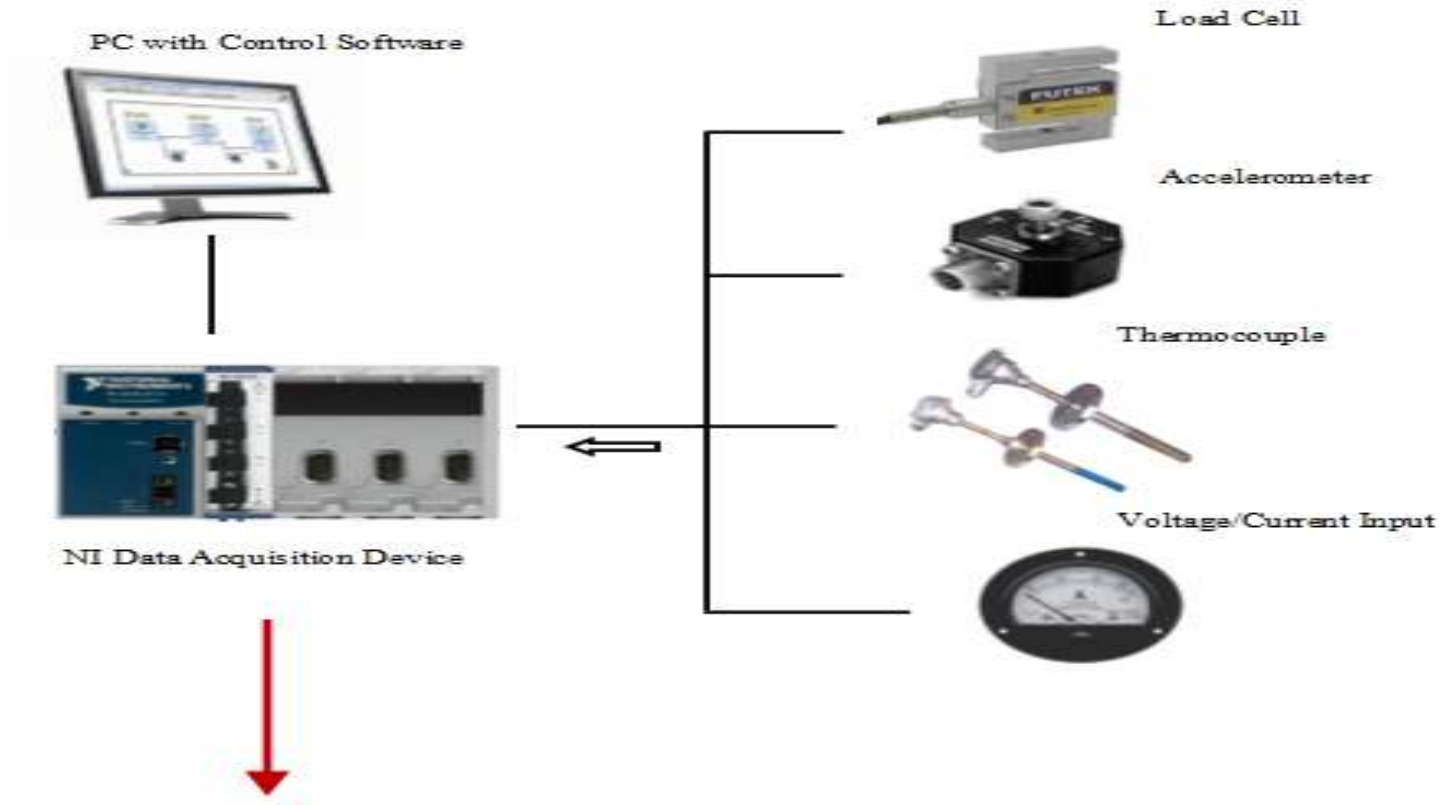
Control System Design

- **Algorithm to Mitigate Dysfunction**

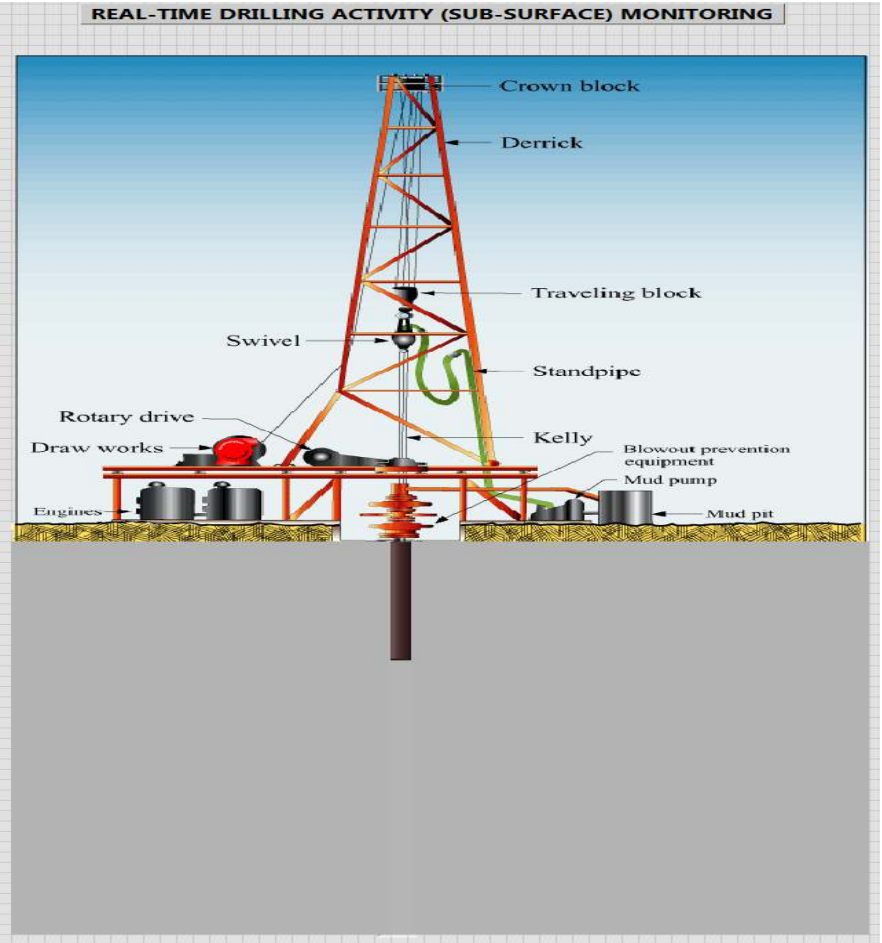
Type of Dysfunction	WOB	RPM	Concern
Whirl	↑	↓	Yes
Stick-Slip	↓	↑	Yes
Bit Balling	↓	↑	No
Bottom-hole balling	-	↑	No
Interfacial Severity	↓	-	May be

Control System Design

- **Instrumentation**



Simulation Features



- Simulation of the design is performed using National Instruments graphical programming software LabVIEW
- In the absence of actual sensors, actuators or data acquisition devices, we made use of NI simulated devices to fabricate the data
- Data Visualization – Real time monitoring of drilling operation down-hole

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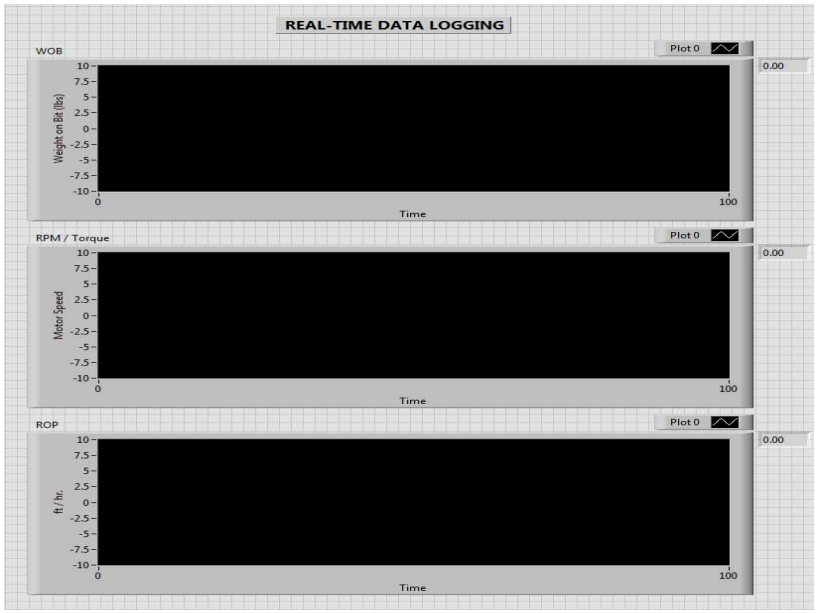
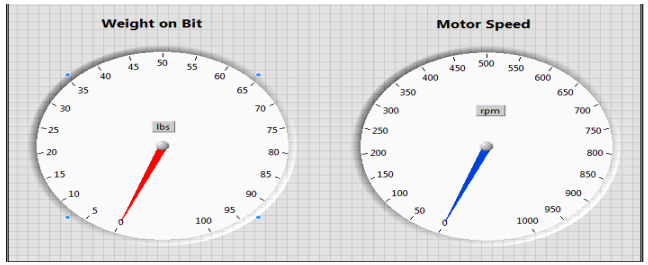
Simulation Features

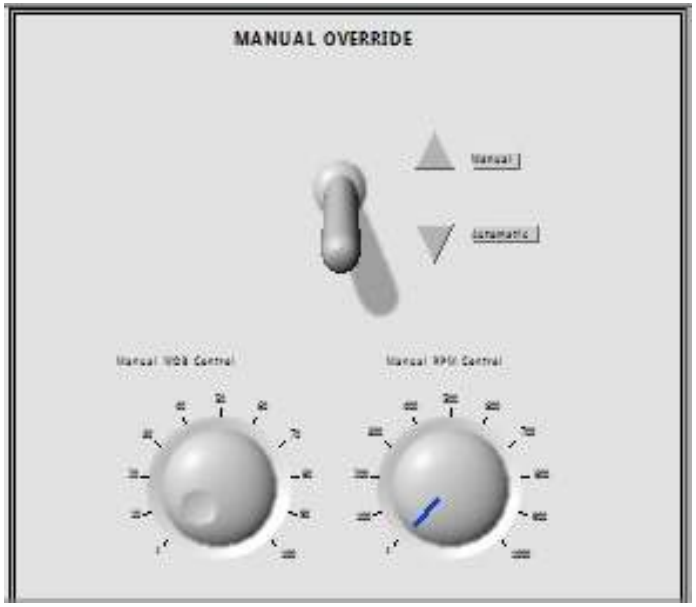




- Data Visualization – Real Time Data Logging

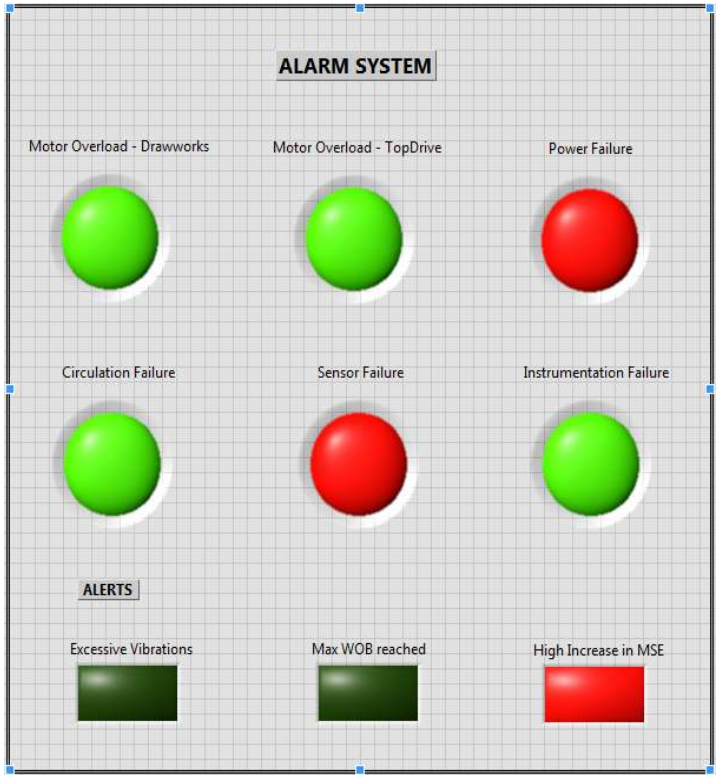
Simulation Features

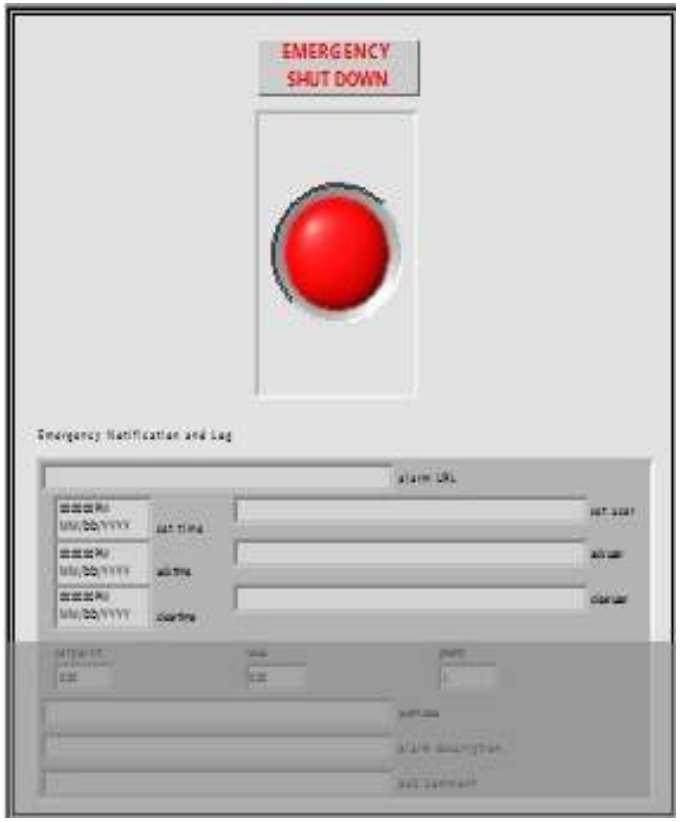
- Manual Override and Control using Joystick



Simulation Features

- Alarm System

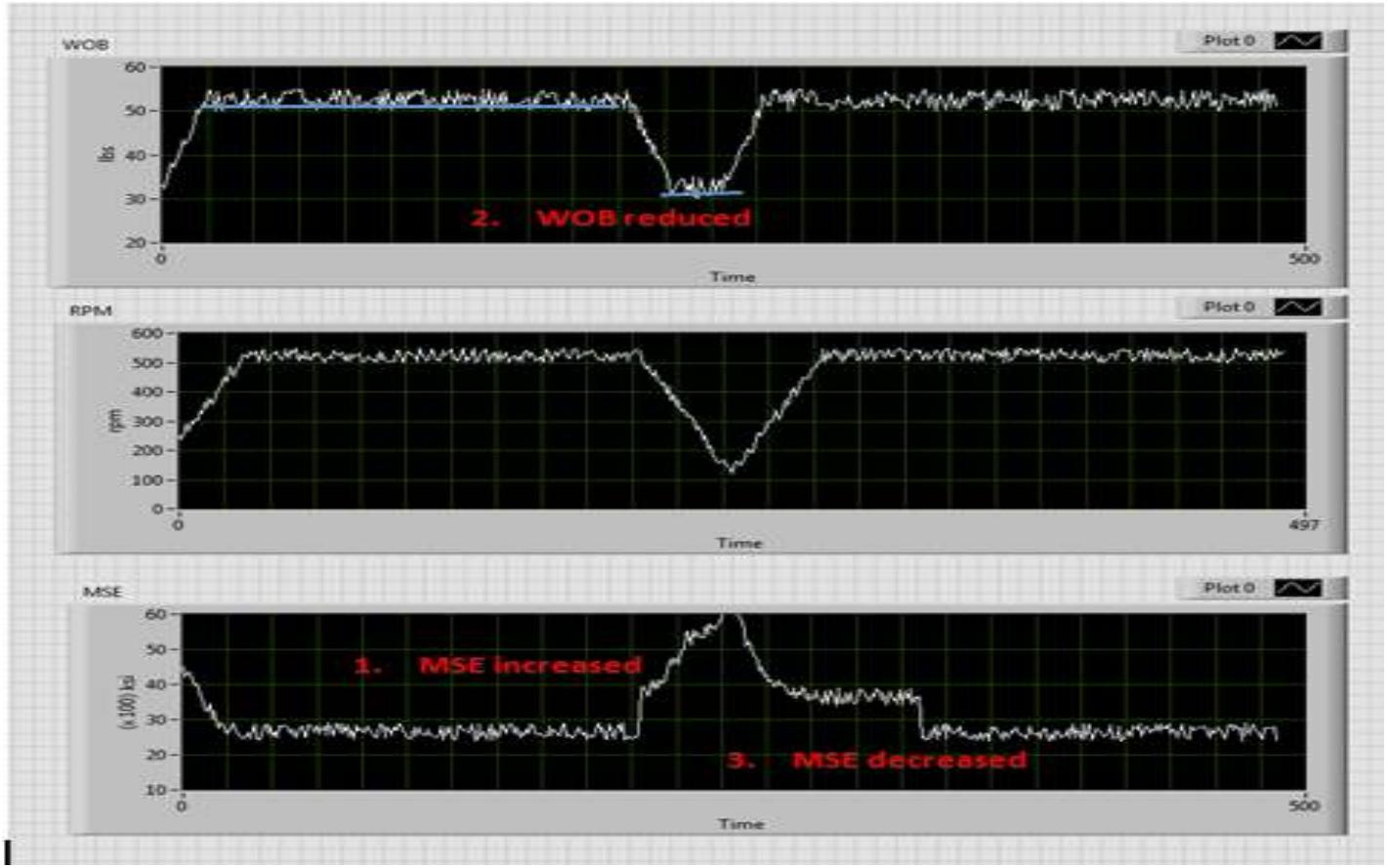




Source : Prof. Fred Dupriest Lecture notes on Bit Mechanics

Simulation Features

- Simulation Results



Conclusion

- We will fabricate a miniature drilling rig with the functionality of an actual rig
- Full drilling automation will be carried out with ROP optimization in mind using the MSE concept
- The project will also be beneficial to the university and in achieving drilling automation