Team 6 – Al-Dhahran Team

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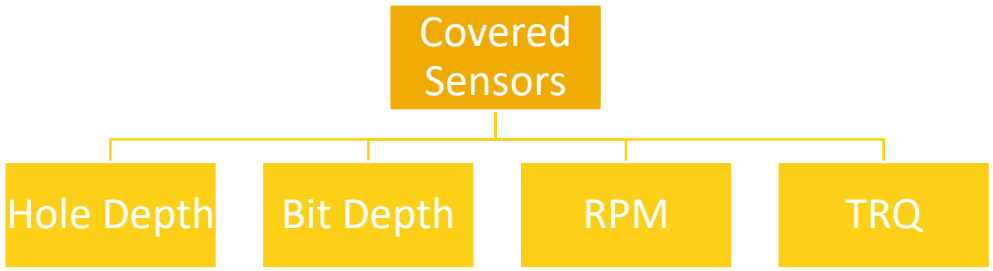
Approach Methodology

1. Check validity
2. Identify drilling operation
3. Apply logical rules
4. Generate a new dataset for each sensor
5. Build a Random Forest Classifier to check reliability and validity
6. Correcting the data by LSTM Model

Covered Sensors



Dataset Prep: Validity Check

- Data Validity Check: Range Check

Sensor	Minimum Value	Maximum Value
Hole Depth (DMEA)	0	50,000
Bit Depth (DBTM)	0	50,000
RPM	0	500
Torque (TRQ)	0	100

Generate Feature

Valid_DBTM	Valid_DMEA	Valid_BPOS	Valid_RPM	Valid_TRQ

2. Generating operation classification inferential features

Feature	Rule
Making_Hole	$(current\_Hole\_Depth - prev\_Hole\_Depth) > 0$
Block_Movement	$current\_Block\_Position - prev\_Block\_Position$
Off_Bottom_distance	$Bit\ Depth - Hole\ Depth$

Generate Feature

Making_Hole	Block_Movement	Off_Bottom_distance

3. Generating Drilling Operation Features

- Operation classification

Operation	Hole Depth	Making Hole	Off Bottom Distance	Block Movement	Top Drive RPM
Drilling		TRUE	>-0.2	<0.1	>10
Drilling/Rocking	>10000	TRUE	>-0.2	<0.1	5<x<45
Sliding		TRUE	>-0.2	<0.1	<=10
Reaming		FALSE	<=-0.2	<0	>10
Back-reaming		FALSE	<=-0.2	>0	>10
Tripping In		FALSE	<=-80	<0	<5
Tripping Out		FALSE	<=-80	>0	<5

Generate Feature

Drilling	Sliding	Rocking	Reaming	Back Reaming	Tripping In	Tripping Out

4. Generating reliability check features

- Rules:
  1. **TRQ and RPM:** (Reliability_RPM, Reliability_TRQ)
  2. **Current and Previous Hole Depth:** (Reliability_DMEA)
  3. **Hole Depth and Bit Depth:** (Reliability_DBTM)

4.1 Generating reliability check features

1. TRQ and RPM: **RPM > 0, then TRQ > 0**

If the **rule was not met**, TRQ will be considered as unreliable.

2. Current and Previous Hole Depth: **Current Depth >= Previous Hole Depth**

4.2 Generating reliability check features

3. Hole Depth and Bit Depth: **If(Bit Depth-Hole Depth) <= 0.2 and (Bit Depth-Hole Depth) >= -0.2 while (Drilling or Rocking or Sliding operations)** If the **rule was not met**, then deciding the **valid sensor is based on previous reliability check.**

5. Generating sensors classes and the datasets

- Generating Classes and Datasets: **Based on Validity and Reliability the classes will be generated.**

DMEA_Sensor_Class	DBTM_Sensor_Class	RPM_Sensor_Class	TRQ_Sensor_Class

Sensor data correction

- For each timestamp, the proceeding 13 values (~1 minutes) are added as a lag for each record.
- The dataset was cleaned to contain only the valid and reliable values with preceding 13 records with valid and reliable values
- MinMaxScaler Scaling was applied to fit the values between (0,1)
- 70% data was used for training, 5% for validation, and 25% for testing.

Building the model Random Forest (RF)

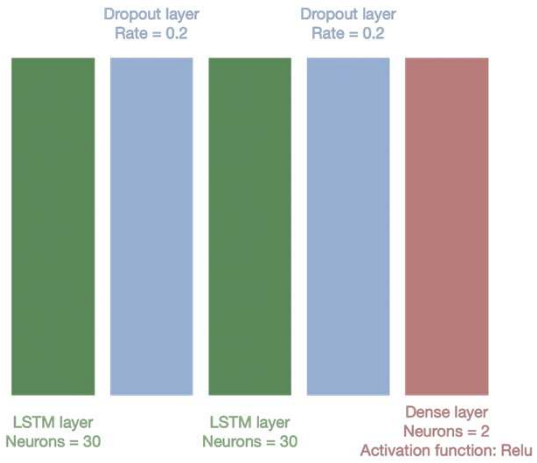
The RF was used to predict the Uncertainty (Validity and Reliability) of the Hole Depth, Bit Depth, RPM, and TRQ sensors.

RF was chosen since it is known best for its reliability on the rules problem solving.

Sensors uncertainty: pred_proba function

Correcting invalid and unreliable data Long Short-Term Memory (LSTM)

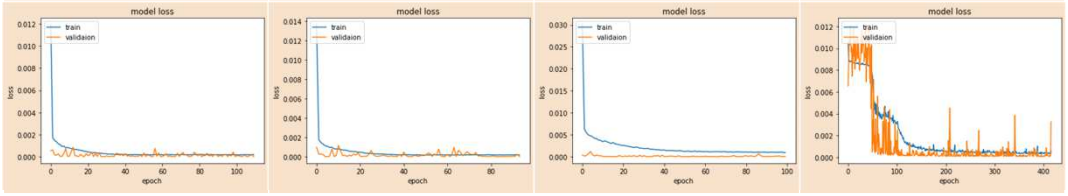
- A stacked LSTM with 2 layers of vanilla LSTM, each containing 30 Neurons to train the model.
- Two layers of dropout to avoid overfitting



Correcting invalid and unreliable data Long Short-Term Memory (LSTM)

- The results of the LSTM Model is as follows,

Correlation Coefficient			
Hole Depth	Bit Depth	RPM	TRQ
0.963	0.977	0.976	0.962



Webinars

Thank you!