Classification of Images in Real Time with Image Analytics
Robbert Schuurmans

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DID YOU KNOW

Agenda

- Wintershall Dea company introduction
- Wintershall Dea digital road map
- Shale Shakers – information, monitoring and NPT events
- Introduction into computer vision
- Workflow followed
- Results
- The way forward
- Conclusion
About Wintershall Dea – Global presence

- Daily production (boe)
- Actual (2019) – 590,000
- Target (2023) – 800,000

Wintershall Dea – Digital road map for Well Engineering

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Shale Shakers – first line of defense

- Drilling fluids are ‘key’ to efficient and safe operations
- First “line of defense” to maintain its quality are: Shale Shakers!

Shale Shaker Operating Efficiency depends on:

- Status of the screens - No Damages (holes) or blinded-out by polymers / sand, do we have build-up of dry patches?
- Utilization, where is the beach on each shaker - Is the workload distributed evenly between the shale shakers?

Shale shakers - A crucial source of information

- Shaker as source of information:
  - Formation identification – Which formation is coming over the shaker?
  - What are the percentages? (60% sand – 40% shale)
  - Cuttings shape and size (rounded, splintery, any cavings?)
  - Volume of cuttings – are we cleaning the hole?
- Foreign objects (debris)
  - Rubber from cement plugs / darts or failing downhole motors
  - Metal – shavings from casing or BHA
Shale shaker – Reporting back to the drilling team

- The quality of reports coming back from the shaker depends on:
  - Level and type of training received by the crew
    Mud Engineer / Mud logger / Roustabout will make different observations from the same situation.
  - What is the level of understanding of the operational needs. What are the key observations? What should they look-out for?
  - Experience – could be anything between 1 day and many years
  - Focus – long shift / weather conditions / day night / motivation

Consequence of ineffective monitoring

Consequence of ineffective monitoring:
  - Additional mud conditioning - caused by damaged screens
  - Hole stability problems:
    - caused by failing to report cavings or an increase in cuttings returns
  - Losses / gains as result of an increased ECD
    - caused by failing to accurate report cuttings volumes
  - Well control issues - caused by failing to identify formation tops. (Seismic +/- XXm)
  - Casing damage – BHA damage
    - caused by failing to report (timely) metal shavings, swarf, rubber (PDM motor, plugs, O-rings) coming over the shakers
“Computer vision aims to build autonomous systems which could perform some of the tasks which the human visual system can perform (and even surpass it in many cases).” [1]

Computer vision to support the human eye
- Monitor equipment status (screens) 24/7
- Detect events (flow rate distribution)
- Recognize object (cutting, debris)

Computer vision - examples

High Level Workflow

- Video Capturing
- Images Extraction
- Pre-Process
- Feature Extraction
- Algorithm Training
- Classification
Video Capturing - First attempt: @Field conditions

- Location: onshore well in Germany
- Perceived advantages:
  - Own operated well – easier to get commitment from the drilling team
  - Known drilling contractor and service suppliers
  - Familiar operations – 14 day / well, known operations & formation types
  - Local specialist to rig-up / rig down communication & video equipment
  - Conventional land rig - Single bed shale shaker
First attempt: Setup

- Mega pixels & FPS
- Type of lens
- Data storage / hard drive
- Water spray / wiper
- Mounting frame

First attempt: Labelling

- The Video and cuttings were correlated using the rig time. (not depth)
  - At 20:08, cuttings from 2,083m are on the shakers.
- After ‘cleaning and drying’ the cuttings description will be added to the time stamp.
- The ideal outcome of the classification will be that the computer can identify size and formation type when cuttings are coming wet over the shakers.
First attempt: Issues

- Camera installation
  - Non oilfield crew used for the installation.
  - Real time feed to the office for QC control and wiper operation
  - Total of 3 days for the installation (power cables, data cables, etc)

- Operating
  - Issues with the auto focus, connectivity and shaker selection
  - ‘Zoom in’ was abused by all project members
  - Issues with rig light at the shaker area
  - Shaker selection

- Data storage
  - Security camera protocol was used. Does not allow normal copying, leading to one moment time, were we thought we lost all our data.

Video Capturing – 2nd Attempt at controlled conditions:

- Location: “Cubility test center in Norway”

  Advantages:
  - The screen conveyor belt is more stable
  - Pre installed camera
  - No issues with fog and or mud splashes
  - Constant light source from inside or outside
  - Test center with flow loop, facilities to add and remove cuttings
### 2nd Attempt - Setup

![Image of setup](image)

### 2nd Attempt - Test program

<table>
<thead>
<tr>
<th>Test #</th>
<th>Time (min)</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>Belt stationary - cube off</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>Cube on - no flow</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>Beach at slow flow rate</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>Beach at medium flow rate</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Beach at maximum flow rate</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>Overflow</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>cuttings type 1 only</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>cuttings type 1 50% type 2 50%</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>Cuttings type 1 50% type 3 50%</td>
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<tr>
<td>10</td>
<td>5</td>
<td>Cuttings type 2 only</td>
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<tr>
<td>11</td>
<td>5</td>
<td>Cuttings type 2 50% type 3 50%</td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>Cuttings type 3 only</td>
</tr>
<tr>
<td>13</td>
<td>5</td>
<td>UFO’s - rubber (plugs)</td>
</tr>
<tr>
<td>14</td>
<td>5</td>
<td>UFO’s - metal (swarf)</td>
</tr>
</tbody>
</table>

Cutting Type 1: 0-1mm  
Cutting Type 2: 1-4mm  
Cutting Type 3: 4-10mm

Test 1 – 6: Screen utilization / flow  
Test 7-12: Shape, type and volume of cuttings  
Test 13-14: Foreign objects (Rubber & Metal)
2nd Attempt – Video capturing

- Beach at slow flow rate
- Overflow

Cuttings Type 1 only
- Cuttings Type 1 50%
- Type 3 50%
2nd Attempt – Video capturing

UFO’s - Rubber (plugs)  
UFO’s - Metal (swarf)

Computer Vision Process Flow

Images Extraction  
Pre-Processing  
Feature Extraction  
Algorithm Training  
Classification
Images extraction

- Video footage is recorded at 30 FPS
- 1 Test is 5 minutes = 9,000 pictures.
- ‘Only’ 1,000 pictures are needed for the computer learning.
- 3 pictures per second extracted.
- 75% Train/Test Ratio
Pre-Process

- Top portion of the image was cropped
  - Remove time stamp
  - Remove people that appear

Computer Vision
Process Flow
Feature Extraction

- Feature extraction is needed to reduce the features on a picture for more efficient data processing.
- One normal picture has +/- 9,000,000 features.
- After feature extraction this can be reduced, depending on the method, to anything between 11 (Haralick) or 3,000 (deep learning) features.

Computer Vision Process Flow
Classification Algorithms

- 5 Different types of classification algorithms were applied to assign a picture to the correct test (1 - 14).

Rating the results

- Three calculations are computed to rate the results of the classification.
  - Precision: the ability not to make a mistake
  - Recall: the ability to find all the positive samples
  - F1 score: is calculated to grade the interpretation between 0 and 1
Interpreting Results – Confusion Matrix

- A confusion matrix is generated which visualizes the performance of the classifier.

Results @ 75% Train/Test Ratio - Data set#2
Feature Extraction vs Algorithm Performance

<table>
<thead>
<tr>
<th></th>
<th>LinearSVC</th>
<th>LogR</th>
<th>MLP</th>
<th>RFC</th>
<th>SVC</th>
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<tbody>
<tr>
<td>HOG</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>31%</td>
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<tr>
<td>Halarick</td>
<td>2%</td>
<td>66%</td>
<td>7%</td>
<td>87%</td>
<td>75%</td>
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<tr>
<td>InceptionResNet</td>
<td>100%</td>
<td>99%</td>
<td>99%</td>
<td>89%</td>
<td>98%</td>
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<tr>
<td>ORB</td>
<td>93%</td>
<td>93%</td>
<td>1%</td>
<td>68%</td>
<td>2%</td>
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- Best performance (near 100%)
  - HOG with LinearSVC, LogR and MLP
  - InceptionResNet with LinearSVC, LogR and MLP

Results @ 25% Train/Test Ratio
The way forward

Individual Cuttings labelling

<table>
<thead>
<tr>
<th>Pancake</th>
<th>Angular</th>
<th>Normal</th>
<th>Metal</th>
<th>Rubber</th>
<th>Splintery</th>
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<tbody>
<tr>
<td>524</td>
<td>342</td>
<td>574</td>
<td>426</td>
<td>658</td>
<td>4</td>
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</table>

- Screen utilization & Cuttings volume calculation. (2*2D = 3D?)
- Damaged screen identification
- On site ‘Quick learning’ option of certain screen conditions
- Train the algorithm with real screen conditions on the rig.
The way forward

- And of course analyzing data set#1

Conclusions

- Computer vision is a very powerful technology. In this project we did not make use of its full potential yet. (data set#1?)
- Test results are better than expected. With some confidence it will be possible to identify real time flow patterns, cutting shape & volumes, screen damages or foreign objects coming over the shakers.
- The labelling of individual cuttings is very labour intensive and causes a risk to the further development of the project.
- Close collaboration of computer vision professionals (Landmark) and SME’s on this type of projects is essential.
Latest results from individual tracking of cuttings

Your feedback is very important to us. Please open the LIFE2019 app to answer a few short questions on this presentation.
Thank You