EVALUATION OF A NEW VISION SYSTEM ALGORITHM FOR AUTOMATED FRAGMENTATION MEASUREMENT FROM A SHOVEL

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FRAGMENTATION MEASUREMENT FROM A SHOVEL

• The view from a vision system on a shovel
  – Capture rate: ~1 frame every 3 seconds
SHOVEL VISION SYSTEM

- Synchronised stereo cameras
  - 3D surface profile of the muck fragmentation
3D MAPPING AND RANGE RESOLUTION

- Synchronised stereo images
- 3D software engine for photogrammetric analysis
- Range to object mapped into an image

\[ \Delta r = \frac{r^2 \Delta d}{bf} \]

\[ \Delta d \approx \frac{1}{4} \text{ pixel size} \]

Range resolution decay with distance for Orica Vision Systems
Calibrated Vision System Auto-Analysis on 12 New Images Compared with Manual Analysis

- Manual Analysis
- Calibrated BVS Auto-analysis
THE PROBLEM WITH FINE DISTRIBUTIONS
DEALING WITH FINE DISTRIBUTIONS

• The whole calibration process can struggle with too fine a distribution
  – Works better if there is coarse material in the image

• Prefer an automated analysis that does not require analysis calibration

• Need a system that can handle fine distributions in the muck pile
  – Hardware changes (camera resolution and/or camera baseline)

OR

  – Draw on other information that’s collected

“This is a fine mess that you’ve gotten us into Ollie.”
IMPROVING THE DETAIL BY USING BOTH 2D AND 3D INFORMATION

Comparison of Vision System performance with manual analysis

- 3D Algorithm
- Manual Analysis
- New Hybrid Algorithm
A HYBRID 2D/3D SOLUTION

• Improve the systems segmentation performance on the small fractions
  – Use raw 2D image for primary segmentation
  – Use 3D information to clean up errors in the 2D segmentation

• To use 2D
  – Need to remove image noise
    › Uneven lighting
    › Shadows
DEALING WITH LIGHT GRADIENTS

• Segmentation performance under variable lighting across the image
DEALING WITH SHADOWS

• Automated segmentation performance with high contrast shadows across an image
PERFORMANCE ON NON-IDEAL IMAGES

Comparison of a BVS auto-analysis for a typical night-time image with a manual analysis

Comparison of a BVS auto-analysis for an image containing a shadow with a manual analysis
NEW HYBRID 2D/3D ALGORITHM VALIDATION

- Test the fully-automated BVS analysis using the hybrid 2D/3D algorithm compared to a diligent manual analysis

Mine 1, Chile, 28 consecutive images captured across day and night

Comparison of the BVS auto-analysis and corresponding manual analysis of 28 consecutive images captured from a shovel in March 2014

Absolute difference in bin percentage between the BVS auto-analysis (hybrid algorithm) and a manual analysis of 28 consecutive images
NEW HYBRID 2D/3D ALGORITHM VALIDATION

- Test the fully-automated BVS analysis using the hybrid 2D/3D algorithm compared to a diligent manual analysis

Mine 2, Chile, 23 consecutive images captured during daylight hours

**Comparison between a manual analysis and the BVS auto-analysis of 23 images captured from a shovel during daylight hours in July 2014**

**Absolute difference in bin percentage between the BVS auto-analysis (hybrid algorithm) and a manual analysis of 23 consecutive images captured during daylight hours**
NEW HYBRID 2D/3D ALGORITHM VALIDATION

- Test the fully-automated BVS analysis using the hybrid 2D/3D algorithm compared to a diligent manual analysis

Mine 3, Australia, 35 consecutive images captured during daylight hours

Comparison between a manual analysis and the BVS auto-analysis of 35 images captured from a shovel during daylight hours in August 2014

Absolute difference in bin percentage between the BVS auto-analysis (hybrid algorithm) and manual analysis of 35 consecutive images captured during daylight hours
CONCLUSION

• The automated 2D/3D hybrid algorithm has dramatically improved the raw accuracy of the measurement such that calibration is not required
  – 2D image texture has improved finer particle delineation dramatically
  – The resolution in the analysis has improved (5 cm → 2.5 cm at 14 m)
• The algorithm is now more robust to varying fragmentation distributions