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Performance Comparison of Commercial Software Tools to Determine Size Distribution of Fragmented Rocks

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Abstract: Rock fragmentation can show the quality of blasting. Screen analysis can be also a precise method to determine size distribution of blasted rocks, but it is a difficult undertaking and sometimes impossible that is due to the time consumed and large volume of crushed rocks. Nowadays, digital image processing is used to evaluate the rocks fragmentation due to its acceptable accuracy and speed. In this research, WipFrag and Split Desktop were compared for evaluation of crushed rocks. Case study was focused on fragmented rock in Jajarm limestone mine. At the first, an image was delimited manually in the both software. Then the results were compared with screen analysis, showing that the results of Split Desktop are closer to the screen analysis results. Maximum difference between screen analysis and results of Split Desktop and WipFrag is equal to 3.59% and 11.38%, respectively. Some comparative modes including the delimitation method effect (automatically and manually), the image rotation effect, and the separation of an image into four quarter images and a combination of the results are investigated. Maximum difference between the automatically and manually delimitation by Split Desktop and WipFrag is equal to 1.28% and 3.79%. Maximum difference for the image rotation effect for Split Desktop and WipFrag is equal to 1.96 perc%ent and 8.09% and Maximum difference for the separation of an image effect for Split Desktop and WipFrag is equal to 3.01 percent and 9.58 percent. Consequently, in all modes investigated the Split Desktop shows more efficient results.

Keywords: Size distribution, Screen analysis, Digital image processing, Split Desktop, WipFrag.

INTRODUCTION

Distribution of fragmented rock mass is one of the most important factors in blasting management.

The most accurate and reliable and the only direct way to determine the dimensional distribution of the fragments is screen analysis. But this method requires a great deal of time and cost spending to obtain the proper distribution of the fragmentation [1]. Due to the limitations of screen analysis, indirect approaches such as observational, experimental and image processing methods have been developed [2]. Determining the distribution of blasted rock mass to provide optimal blasting patterns and achieve proper crushing is one of the most important applications of image processing [3]. Goldsize, Split Desktop and WipFrag are popular image processing software.

Maerz et al. (1996), using early versions of the WipFrag software, are analyzed images of crushed rock samples and outlined the advantages and limitations of this software [4]. Esen et al. (2000) are used Split Desktop software to process images and compare the results of crushing due to limestone blasting [5]. Venkatesh et al. (2013) are evaluated the crushing results of 102 and 165 mm explosive borehole by using WipFrag software to optimize drilling and blasting operations in the iron ore mine [6]. In 2015, Jahani and Taji have validated post-blasting fragmentation prediction models for both hematite and magnetite ore using Split Desktop software [7].

The present study was conducted to validate two WipFrag and Split Desktop software with the results of screen analysis and selection of suitable software for fragmented limestone image processing. The most important feature of the two software is the ability to detect and determine the boundaries of rock fragments, which greatly reduces processing time.

METHODS

The technical comparison between Split Desktop and WipFrag is done in different ways. The software used is first validated by the result of the screen analysis, and then different modes are considered for image processing of special picture.

Step 1- Validation of software by screen analysis

Screen analysis is the only accurate and reliable method for determining the distribution of material. Therefore, it is necessary to compare and validate the distribution results of the softwares with screen analysis results.

Step 2- Studying of the effect of boundary type on processing results

In order to validate the software results by screen analysis, the Bordering of fragments in the both software was done manually and with high accuracy. Since the two software have still the capability of automatically bordering of fragments, it is important to determine the precision of the fragment's bordering in the software.

Step 3- Investigation of image rotation effect

Due to the irregular shape of the fragmented rocks, the calculated size for the fragments may change when the image is rotated and therefore change the processing results.

Step 4- Investigation of the effect of image segmentation and composition of curves

In order to investigate the effect of sample size on processing results, a specific image is divided into four parts. Each quarter of the image is automatically bordered and processed separately by the both software. After finishing the processing of the four images, the resulting distribution curve of the combination of the four curves (for each quadrant) is compared with the curve of the full image auto-bordering.

FINDINGS AND ARGUMENT

Figure 1 shows the distribution curve obtained by image processing using WipFrag and Split Desktop software and its comparing with the distribution curve of screen analysis. As can be seen in the figure, the results of Split Desktop software are more in line with the results of the split analysis.

Table 1 presents the differences between the results of manual and automatic bordering of fragmentations using Split Desktop and WipFrag software. As can be seen in Table 1, the minimum and maximum differences in Split Desktop software are 0.01% and 1.28%, respectively. While the minimum and maximum differences for WipFrag software are 0.07% and 3.79%, respectively. Therefore, the results of automated and manual bordering are more consistent with Split Desktop software.

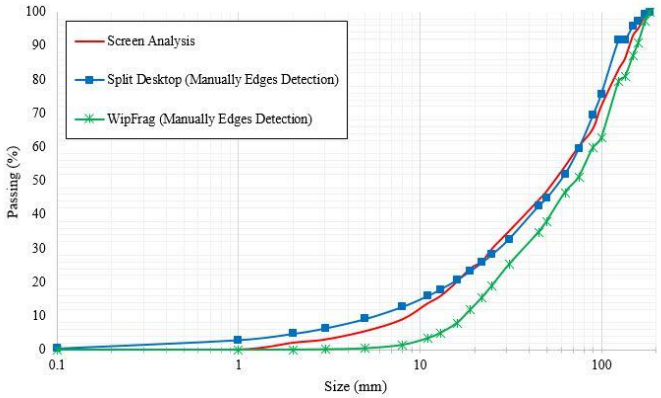
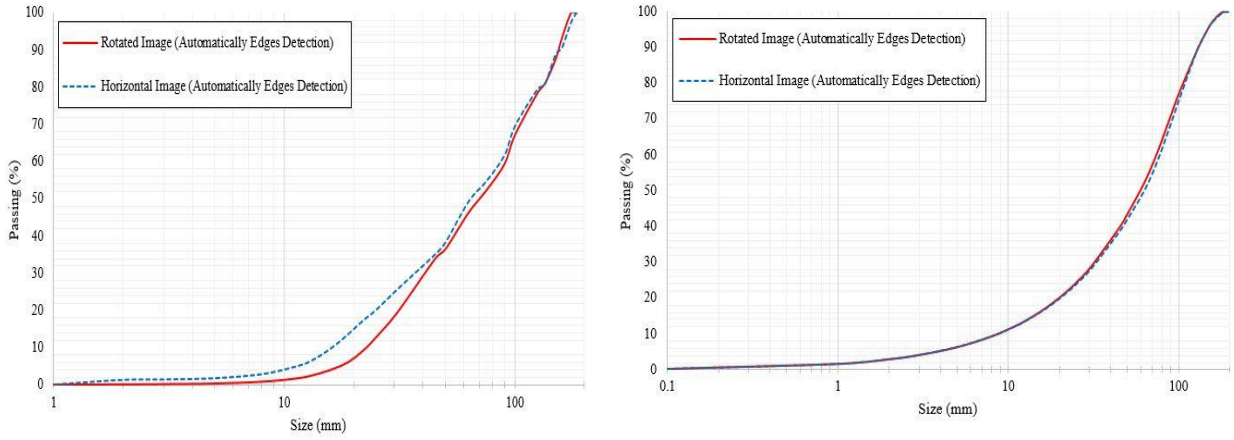


Figure 1. Distribution curve results

Table 1. Differences between manual and automatic bordering

Row	Fragment size (mm)	WipFrag			Split Desktop		
		Automatic bordering	Manual bordering	Differences	Automatic bordering	Manual bordering	Differences
1	10	4.7	3.58	1.12	14.98	15.92	0.94
2	20	13.64	12.62	1.02	22.5	23.32	0.82
3	30	25.66	26.8	1.14	31.5	32.78	1.28
4	50	38.22	40.33	2.11	45.3	44.83	0.47
5	63	49.21	49.14	0.07	51.98	51.93	0.05
6	75	54.57	54.02	0.55	58.47	59.43	0.96
7	90	61.55	63.34	1.79	68.97	69.36	0.39
8	100	69.42	65.63	3.79	75.29	75.57	0.28
9	150	88.68	90.71	2.03	95.79	95.8	0.01

Figure 2 shows the output curves of the WipFrag and Split Desktop software for landscape image and image rotation mode. As can be seen, the output curves of the WipFrag software have differences that indicate the effect of image rotation on the output results of this software. On the other hand, Split Desktop software results are more consistent in both cases.



WipFrag Software **Split Desktop Software**

Figure 2. Output Curves in Horizontal and Image Rotation

Comparative analysis of the results obtained from the two software for evaluating the effect of image segmentation is presented in Table 2. The lowest and highest differences for Split Desktop software are 0.09% and 3.01%, respectively. While, the lowest and highest differences for WipFrag software are 0.98% and 9.58%, respectively. Therefore, the results of image segmentation and curve composition in Split Desktop software are more consistent than WipFrag software.

Table 2. Comparison of results of composition of four-quadruple and results of full-image

Row	Fragment size (mm)	WipFrag			Split Desktop		
		Initial Image (Not segmented)	Combination of four quadrants of the image	Differences	Initial Image (Not segmented)	Combination of four quadrants of the image	Differences
1	11	4.7	10.05	5.35	14.98	14.8	0.18
2	13	6.3	12.57	6.27	17.65	17.05	0.6
3	16	9.8	15.59	5.79	20.1	20.83	0.73
4	19	13.64	18.7	5.06	22.5	22.3	0.2
5	22	17.27	20.92	3.65	25.14	24.99	0.15
6	25	20.05	23.18	3.13	27.36	26.86	0.5
7	31	25.66	27.2	1.54	31.5	31.02	0.48
8	45	34.94	39.56	4.62	41.08	40.8	0.28
9	50	38.22	43.44	5.22	45.3	43.5	1.8
10	63	49.21	53.07	3.86	51.98	51.89	0.09
11	75	54.57	60.78	6.21	58.47	61.1	2.63
12	90	61.55	65.49	3.94	68.97	71.98	3.01
13	100	69.42	68.44	0.98	75.29	78.16	2.87
14	125	79.28	85.97	6.69	88.12	89.66	1.54
15	135	80.75	90.33	9.58	91.72	92.83	1.11
16	150	88.68	92.15	3.47	95.79	96.42	0.63
17	160	90.52	100	9.48	97.53	97.96	0.43
18	175	97.29	100	2.71	99.31	99.45	0.14

CONCLUSIONS

Split Desktop software performs better than WipFrag software in terms of proximity of results to reality (screen analysis). Regarding the automatic bordering of *fragmentations* and its difference with manual bordering, the results are almost identical. However, the results from Split Desktop software are better than WipFrag software. Due to the irregular shape of the fragments, the effect of the image rotation is investigated and the result is compared with the original image state. WipFrag software has been somewhat affected by this effect, while such a phenomenon has no effect on the results of Split Desktop software. Also, the investigation of image segmentation and curve composition show that the Split Desktop software is more reliable than WipFrag software. Finally, after comparing the two software in different conditions, Split Desktop software is more accurate than WipFrag software and has the least effect of different processing conditions.

REFERENCES

[1] Sudhakar, J., Adhikari, G. R., and Gupta, R. N. (2006). "*Comparison of Fragmentation Measurements by Photographic and Image Analysis Techniques*". Rock Mechanics and Rock Engineering, 39(2): 159-168.

[2] Siddiqui, F. I., Ali Shah, S. M., and Behan, M. Y. (2009). "*Measurement of Size Distribution of Blasted Rock Using Digital Image Processing*". Engineering Science, 20(2): 81-93.

[3] Karaca, K., Hopkins, D., Kemeny, J., and Segui, J. (2003). *"Technologies for Optimizing Drilling and Blasting in Open-Pit Mines"*. In International Mining Congress and Exhibition of Turkey-IMCET, 191-198.

[4] Maerz, N. H., Palangio, T. C., and Franklin, J. A. (1996). *"WipFrag Image Based Granulometry System"*. In FRAGBLAST 5 Workshop on Measurement of Blast Fragmentation, Montreal, Quebec, Canada, 91-99.

[5] Esen, S. (2000). "*What's New With The Digital Image Analysis Software Split-Desktop?* ". by Tom BoBo, Split Engineering, LLC, Tucson, Arizona, USA.

[6] Venkatesh, H. S., Vamshidhar, Gopinath, K. G., Theresraj, A. I., and Balachander, R. (2013). "*Optimisation of Blast Design for an Iron Ore Mine and Assessment of Fragmentation Through Image Processing*". Taylor & Francis Group, London, pp. 10.

[7] Jahani, M., and Taji, M. (2015). "*Comparison of Empirical Fragmentation Models at the Gol-e-Gohar Iron Ore Mine*". The 11th International Symposium on Rock Fragmentation by Blasting, 11: 707-713.