Digital Image Processing Technique for Particle Size, Shape and Mineralogical, Textural Analysis

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Abstract: Aggregate size and shape measurements are extremely important issues in mining and construction industry because of it directly affect the performance of aggregate products, also there is a prime need of textural analysis in many fields including geological and geotechnical studies. Traditional methods are time consuming and complex. In the present research, we applied DIP (Digital Image Processing) techniques for grain size analysis. Mainly, there are four sections which are unattached particles/fragment analysis, Attached particles/fragment Analysis, Moving particles/fragment Analysis and Colour, texture based classification. In unattached particles analysis, particles were spread without contacting each other and then analysis was done. In attached particles analysis, watershed transformation was applied to distinguish particles and then analysis was done. Moving particle analysis were performed by acquiring a video of free falling particles and generating contact-less flow of particles using video processing techniques. Colour and Texture based classification was done by separating the RGB (red, green, blue) bands and calculating mean, standard deviation and smoothness and then k-mean classification were performed. Finally results from Image processing methods were compared with the conventional methods. The method developed by the research was successfully applied in aggregate and sediment analysis.

Keywords: PSD (Particle Size Distribution), Shape, Texture, DIP (Digital Image Processing).

1. Introduction

Characterization of particle size and shape of aggregate and sediments are extremely important issues in mining and construction industry (Maerz *at el, 1998*) as well as geological and geotechnical studies. Since, the particle size and shape characteristics are directly affect the performance of aggregate products, it is required to asses those characteristics in a proper manner. The main mechanical procedures for size and shape measurements is sieve analysis (wet and dry) but this traditional method associated with many errors as well as it is not efficient and cost effective enough to utilize with a high productive aggregate production line. Particle size and shape analysis by using DIP (Digital Image Processing)

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techniques is the best available alternative for this problem. DIP method is faster in both data acquisition and data analysis, provide accurate and detailed results. Because of the nature of the equipment and analysis technique use in this method, it and can be integrated to an aggregate production line to provide a feedback for fine adjustment of output particle characteristics in real time.This research is mainly focus on developing Digital image processing technique for particle size/shape, mineralogical and textural analysis.

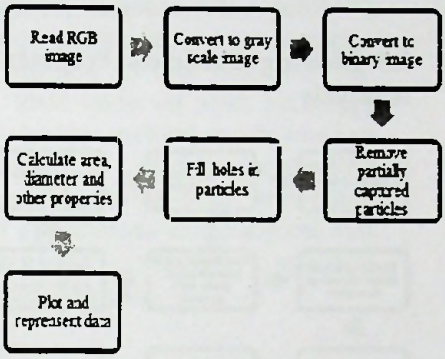
2. Material and Methods

MATLAB image processing tool box is used as the main software tool for developing the technique and data are gathered as photographs and videos. All images and videos were analyzed using developed DIP technique in order to identify particles and their characteristics.

Various software and instruments are available in industry for Particle Size/Shape and Mineralogical analysis. Some of them are MATLAB® toolbox Code "Sand Sieve Analysis", GRADISTAT® software, Split®-Desktop software, WipFrag® system and WipFrag® shape measurements, CAMSIZER® system and QEMSCAN®.

Firstly, images pixels were converted into actual units (scaling factor). This was done manually.This research included following categories,

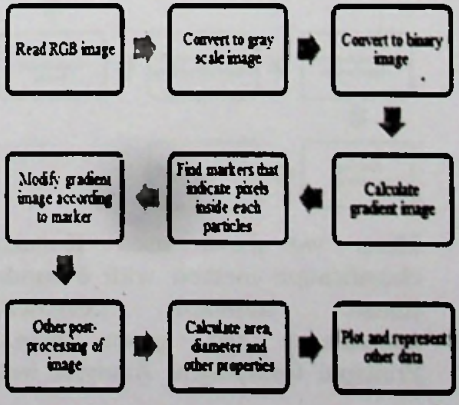
2.1 Unattached Particles/ Fragment Analysis



First, it is needed to distinguish particles from background. Therefore, there should be reasonable colour different (like white background). We have used automatic thresh holding method (Otsu Method) for that.

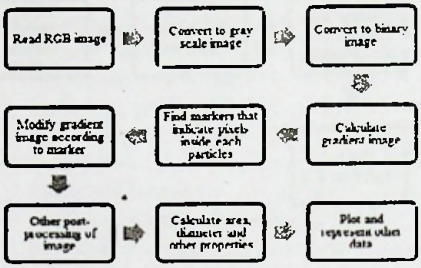
Then onward most of operations have done using Binary image analysis techniques (Morphological Image Processing).

2.2 Attached Particles/ Fragment Analysis



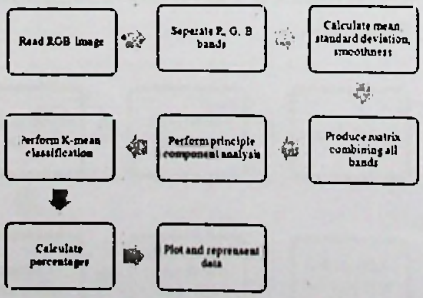
To distigush particles, we have used watershed transformation. Rest of analysis is same as Section 2.1.

2.3 Moving Particles/ Fragment Analysis



In this method, background was extracted first, for that we take several images and take medium of them pixel-wise (background). Difference of background and each frame gives unattached particle image like in Section 2.1. Rest of analysis is same as Section 2.1.

2.4 Colour, Texture based classification



Here, we have used K-mean classification method with 6 bands (mean, standard deviation, smoothness, red, green, blue,). Principal Component Analysis was used to reduce computational complexity.

3. Results

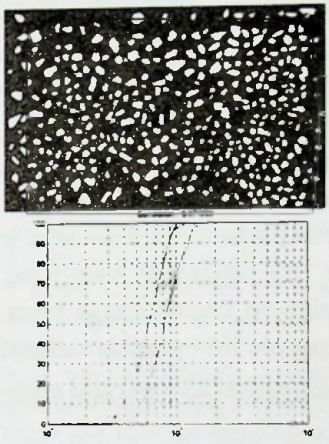


Figure 1 – PSD Unattached Particles/ Fragment Analysis

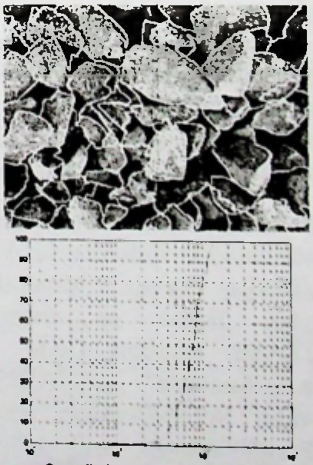


Figure 2 – PSD Attached Particles/ Fragment Analysis

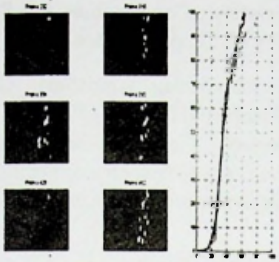


Figure 3 – PSD Moving Particles/ Fragment Analysis

Figure 4 – Colour, Texture based classification

4. Discussion

Development of universal method for all kind of samples/sediments or aggregates is a difficult task. Hence, User intervention in process is required, especially in isolating particles which are in contact with each other. This problem can be solved by moving particle analysis because better particle isolation happen when particles are freely falling.

Since, most of engineering evaluations are based on sieve analysis, it is challenging to develop DIP technique that is compatible with sieve analysis. However, our text results show particular method developed by the research for textural and mineralogical analysis using digital image processing techniques can use many industrial as well as research projects.

5. Conclusion

Reasonable amount of capabilities are depend on camera performances. This method is very fast (may be with little trade off with accuracy) And also this method can be used as automated quality controlling method in crusher plant and many other applications in geological and geotechnical studies specially sediment analysis.

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