Granulometry Using Image Transformation Techniques

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Abstract

In this paper, we present our preliminary study on using transformation-based techniques for performing granulometry analysis. We examine specifically the problem of the particle size analysis in oil sand images. In contrast to conventional methods of size analysis, we avoid the difficult step of image segmentation and derive information about the size distribution of the particles in the images directly by the transformation techniques of Fourier analysis and scale-space decomposition. We have tested our techniques on both simulated artificial data and real video images, and demonstrated the feasibility of the proposed approaches.

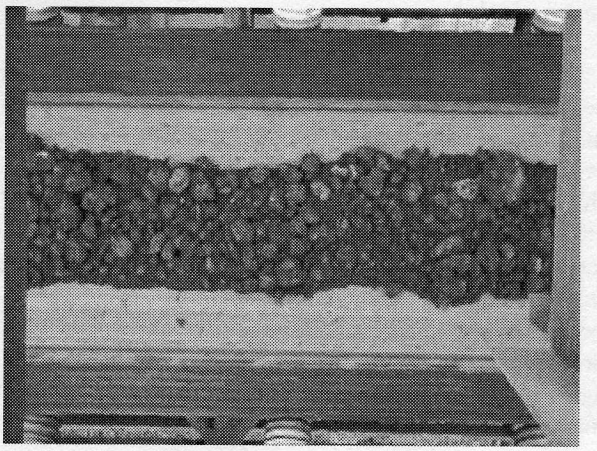

Figure 1: *Oilsand material on a conveyor belt.*

1 Introduction

In this paper, we present two techniques for performing image granulometry, the problem of determining the particle sizes in an image. We specifically focus on the analysis of video streams of oil sands on a conveyor belt (Figure 1), and the computation of statistical size distributions of the oil sand lumps. This work has a direct application in oil sand mining, by providing knowledge to field operators and allowing them to evaluate and optimize oil sand handling equipments.

Although traditional size analysis techniques exist, such as mechanical sieving, centrifugation, and sedimentation, it is highly desirable to use a system based on computer vision to obtain oil sand size information as it does not interfere with or disrupt the production, and allows analysis of a large number of samples, thanks to the relatively high speed of image processing. In addition, a vision-based technique is not invasive, preserving the shape properties of oil sand lumps to be analyzed. Toward this end, a major collaborative research initiative has been in place between the University of Alberta and Syncrude Research (Canada), the world's largest oil producer from oil sand, and a key player in a major industry in the province of Alberta.

There is no known literature on oil sand granulometry using computer vision, except for systems developed for the hard rock industry for analyzing fragmented rocks after blasting [6]. Hard rocks, fortunately, have well-defined edges and their images can be segmented easily using edge-based techniques. In the case of oil sand images, however, edge-based methods fail due to the rich texture of oil sand lumps, and lack of edge information. In addition, since oil sand mining is a 24-hour, outdoor operation, varying lighting and weather conditions play a significant role in the appearance of oil sand. A size analysis system for oil sand based on segmentation must resolve a number of technical challenges that are known to be difficult to computer vision.

In our previous research, we developed a technique for oil sand analysis based on mathematical morphology [2]. We observed that large oil sand lumps appear to be brighter than the fines (small particles) that surround a large lump. This observation led to a morphological segmentation algorithm to delineate individual objects in an oil sand image. There are however several problems with morphological segmentation, as shown in Figure 2. Frequently, for example, small and dark objects cannot be properly segmented, and the areas of the segmented objects are often underestimated. The latter is caused by classifying darker pixels on the perimeter of a lump as not being part of the lump. Other problems include false detection of two objects within one, and classification of a collection of more than one object as