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An Image Segmentation Algorithm for Measurement of Flotation Froth Bubble Size Distributions

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Abstract

The bubble size distribution at the froth surface of a flotation cell is closely related to the process condition and performance. The flotation performance can be reasonably predicted through continuous measuring the bubble size distribution by a machine vision system. In this work a new watershed algorithm based on whole and sub-image classification techniques is introduced and successfully validated by several laboratory and industrial scale froth images taken under different process conditions. The results indicate that the developed algorithms, in particular the sub-image classification based segmentation algorithm, can accurately and reliably identify the individual small and large bubbles in the actual froth images, which is often problematic.

Keywords: Froth flotation, Image classification, Segmentation, Watershed algorithm

1. Introduction

It is well known that the bubble size distribution at the froth surface of flotation cells gives much valuable information regarding the process conditions (i.e. air flow rate, slurry level, pH, reagent dosage and slurry solids%) and performance (i.e. recovery and grade) (Hosseini et al., 2014). Hence, the flotation performance can be reasonably predicted and controlled through continuous measuring the bubble size distribution by a machine vision system (Jahedsaravani et al., 2016; Mehrabi et al., 2014).

Accurately delineating the bubbles in the actual froth images is a challenging task owing to several reasons. The froth images comprise a large number of closely packed bubbles with weak edges which are not easily detectable. A wide range of bubble size and uneven illumination are other difficulties in accurate segmentation of froth images into bubbles (Sadr-Kazemi & Cilliers, 1997; Weixing Wang & Wang, 2000).

In recent years, efforts have been made to develop efficient and speedy algorithms for measuring bubble size distribution in the froth images. The most common techniques include watershed algorithm

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