



Research article

Providing an analytical relationship between the froth color on the cell surface and the copper mineral grade in flotation

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(Received: August 2023, Accepted: May 2024)

DOI: [10.22034/ANM.2024.20444.1605](https://doi.org/10.22034/ANM.2024.20444.1605)

Keywords

Color spaces
flotation cells
mineral grade specification
image processing

English Extended Abstract

Summary

In this paper, by preparing a film with a digital camera from the surface of a flotation cell in the Miduk copper mine in Kerman province, the relationship of the mean color components of existing film frames, Haralick textural features including entropy, image uniformity and energy, as well as the texture complexity feature in three color spaces RGB, YCbCr and HSI with the mineral grade is analyzed.

Introduction

Flotation control is usually performed by observing the surface of cells by humans. The cell surface is mainly adjusted by the operators using the color of the bubble and the texture characteristics. The color of the froth on the surface of cells includes essential information about the mineral content, which is revealed by long-term observation during the flotation process on an industrial scale. Hence, the surface of froth is a fundamental element to evaluate the flotation performance. In this paper, the relationship between the texture color related to the froth on the surface of the flotation cell and the mineral grade is investigated based on image processing procedures. The employed samples in the paper are provided by the Miduk copper mine in Kerman province.

Methodology and Approaches

Taking a movie from the floor surface of the flotation cell was done with a GoPro 6 camera capable of recording 60 frames per second, which was installed at a height of 50 cm from the floor surface. Consistency of the amount of light and the location of the camera is very important for all samples. At the same time as filming, the copper concentrate material is also sampled and sent to the laboratory for copper grading. Filming has been done during 3 months in different weeks and at various times of the day, from an active rougher flotation cell in the concentration section of Miduk copper mine. The result of the work was 109 films of 120 seconds, from each film, 10 frames with a time interval of 12 seconds were extracted as frames of the desired image.

Results and Conclusions

By analyzing the relationship between the mean color components of existing film frames, Haralick textural features including entropy, image uniformity and energy, as well as the texture complexity feature in three color spaces and the mineral grade separately, it is concluded that the intensity parameters in the three color spaces have a value of the correlation coefficient between 0.8461 and 0.8483 with the mineral grade. Performing the regression to estimate the relationship mathematically, and comparing the performed

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regression based on theoretical criteria also confirm the closer relationship of the mentioned parameters with the mineral grade, because for the coefficient of determination, a value between 0.6693 and 0.7302, and the adjusted coefficient of determination, a value between 0.6220 and 0.7271 is obtained. The reliability of grade estimation based on the intensity parameters is evaluated by the root mean square error (RMSE) criterion, which resulted in a value between 2.32 to 2.70 percent, which indicates the superiority of the proposed method.

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