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Limestone chemical components estimation using image processing and pattern recognition techniques

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Abstract
In this study, an ore grade estimation model was developed based on image processing and pattern recognition techniques. The study was performed at a limestone mine in central part of Iran. The samples were randomly collected from different parts of the mine and crushed down (from 10 cm to 2.58 cm). The images of the samples were taken in an appropriate environment and processed. A total of 76 features were extracted from the identified rock samples in all images. Neural network was used as an intelligent tool for ore grade estimation. First, six principal components derived from principal component analysis were used as input of neural network and four grade attributes of limestone (CaCO3, Al2O3, Fe2O3 and MgCO3) were used as the output. The root of mean squared error between the observed values and the model estimated values for the test data set were 0.38, 0.84, 0.15 and 0.03; the R2 values were 0.78, 0.76, 0.76 and 0.81 for the mentioned chemical compositions respectively. The value of R2 indicates the correlation between the actual and estimated data. It can therefore be inferred that the model could successfully estimate the percentage of chemical compositions of the samples collected from the same mine.

Keywords: *Image processing; neural network; ore grade; prediction; limestone*

1. Introduction

Vision-based systems have great success in the mineral industries [1]. A study conducted by Oestreich et al. (1995) demonstrated the use of an online sensor for mineral composition identification [2]. Petruck and Lastra (1993) have determined mineral grade values on a microscopic scale by image processing technique [3]. Shafarenko et al. (1997) used an image-based technique to inspect the quality of granitic rocks [4]. Casali et al. (2000) carried out an ore grind-ability analysis based on vision systems [5]. Ore textural analysis using the image processing techniques was performed by several investigators [6, 8]. The main scope of these studies was to estimate average particle size and various ore type identification in the industrial ore feeding systems [9].

In most cases, the ore grades are determined by manually collecting samples from ore material and analyzing them chemically in a laboratory. The sample collection, preparation and chemical analysis are tedious and time-consuming operations. In this situation, a vision sensor might be a useful technology for grade quality control [10]. Chatterjee et al (2006) developed a vision system based on a neural network that was trained by the image features to estimate the grade of chemical compositions in a limestone mine [10]. In this paper, the effects of different combination of image features on the chemical grade determination were considered. Schematic