Rock lithological classification by hyperspectral, range 3D and color images

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Mine operations in the future will require automatic rock characterization at many different stages, since it can be used to supervise and optimize various processes in the laboratory as well as at the mine locations for planning and exploitation. Different methods for classifying rocks based on image analysis have been proposed in the past. In this paper, we report the use of hyperspectral sensors in the classification of rock lithology. The lithology provides information about the chemical composition of the rock, and its physical properties. According to our literature review, this is the first time hyperspectral sensors have been employed in rock type classification. Additionally, it is the first time the use of three different technologies in rock type classification has been reported: hyperspectral sensors, laser range and a color camera. We use two hyperspectral sensors, one has sensibility within the visible and near-infrared range of 400?1000 nm, and the second has sensibility within the short-wavelength infrared range of 900?2500 nm. The range and high definition color images are used to perform accurate segmentation of the rock samples. Images are tessellated into sub-images in which various features from the three sensor types are extracted. In a first stage, the sub-images are classified by using a support-vector machine (SVM) classifier with the extracted features as inputs. In a second stage, the rock segmentation is used to perform a voting process among all the sub-images of each rock and improve the classification. The method was tested using a database with 13 lithologies from a copper mine in Chile. The results show that lithological classification performance obtained by using hyperspectral images greatly exceeds the performance of the color and range images. The achieved classification performance was 98.62% using sub-image classification and 99.95% using a voting process among sub-images. The number of features was also reduced by using the CMIM (Conditional Mutual Information Maximization) feature

selection method, achieving a performance of over 99% with using only 3% of the total number of features.