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Mineralogical Classification and Concentration Estimation in Mining with App Using Hyper-Spectral Imaging and Machine Learning

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Abstract

This study presents an innovative method for identifying minerals by combining the capabilities of hyperspectral imaging with machine learning. Although hyperspectral images are challenging to process due to their extensive dimensions and substantial size, our solution effectively tackles this complexity by providing a user-friendly machine learning tool specifically tailored for hyperspectral data. This self-developed tool simplifies the process of constructing datasets and enhances machine learning processes for identifying mineral species and estimating their concentrations. The interface is designed to be easy to use, allowing non-experts to effectively identify minerals without needing professional expertise. This is further enhanced by the integration of machine learning capabilities. Our instrument is positioned as an innovative solution that greatly enhances geological surveys in mining regions, leading to useful outcomes for mineral-related research and industrial applications.

Keywords: Hyperspectral Imaging; Spectroscopy; Mineral Processing

List of Abbreviations:

HS - Hyperspectral Imaging; ROI – Regions of Interest; App – Application; CNN – Convolutional Neural Network; UI – User Interface

1. Introduction

While hyperspectral imaging is increasingly being used in a variety of industries, not just the mining industry, there are some challenges [1]. These include the lack of immediacy and usability of the technology, which this research seeks to address. The objective of this research is to present a hyperspectral image analysis tool that could aid in addressing the aforementioned issues and simplify their processing.

(a) The creation of a simple dataset for machine learning applications: (b) The processing of machine learning data: (c) The identification and estimation of mineral species concentrations: (d) The selection of bands for multispectral data processing: and (e) The visualization of data via segmentation.

Hyperspectral data has the potential to be analyzed by machine learning due to its inherent complexity. However, the sheer volume of data presents a significant challenge in terms of data handling [2]. As shown in Figure 1, this tool facilitates user-friendly data manipulation, enabling users to perform operations such as labeling, machine learning, and evaluation for machine learning simultaneously.

2. Results and Discussion

The results obtained by this tool are presented in Figure 2. A machine learning-based regression analysis was conducted on samples with varying concentrations. The left-hand side of the figure displays the pseudo-RGB image, while the right-hand side shows the regression

results. The figure illustrates that the AI was capable of distinguishing differences in density. This tool not only streamlined the processing of hyperspectral data, which had previously been challenging to handle, but also facilitated sophisticated analysis by integrating a user interface (UI) that is tightly coupled with machine learning.

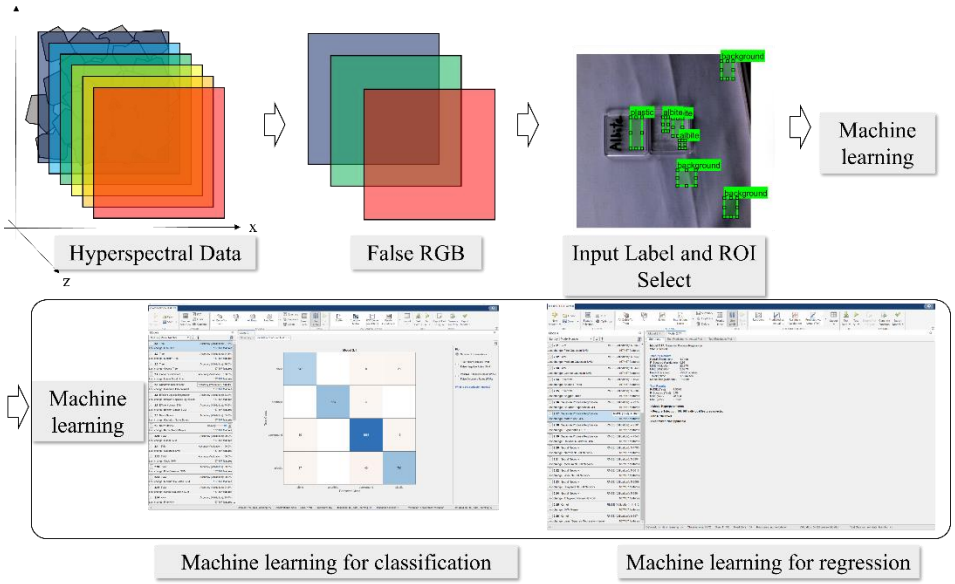

Figure 2 Procedure of hyperspectral image processing.

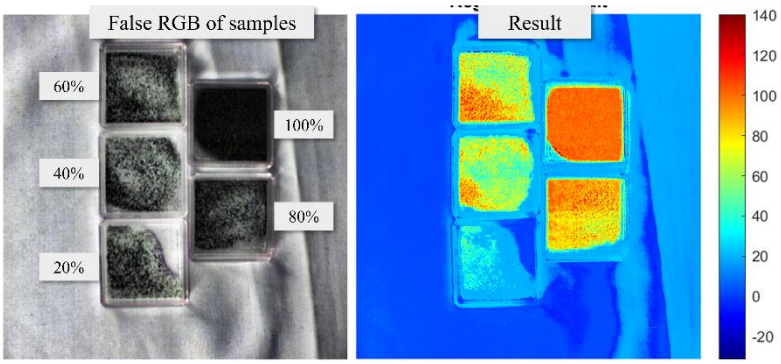

Figure 3 Results of regression analysis.

References

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