AUTOMATIC CLASSIFICATION OF PLUTONIC ROCKS WITH MACHINE LEARNING APPLIED TO EXTRACTED COLORS ON IOS DEVICES

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ABSTRACT

This research extracts dominant shades and colors from plutonic rock images to train several machine learning algorithms and deploy the best model in an iOS app for the automatic classification of four classes of plutonic rocks in order from darker to lighter: gabbro, diorite, granodiorite, and granite.

INTRODUCTION

Plutonic rocks are formed when magma cools and solidifies below the Earth's surface [1]. Lightness and color are properties used for the classification of plutonic rocks; however, these attributes can be difficult to describe because perceived rock colors depend on the observer's experience [2]. Moreover, although the classification of plutonic rocks can be done using data from various instrumental techniques, these approaches tend to be expensive and time-consuming.

METHODOLOGY

We used pictures from plutonic rocks that were classified by using petrography and chemistry data to train the models [3].

1. Color extraction

First, the dominant colors of plutonic rock images were extracted with the k-means algorithm by grouping the image pixels according to the RGB and CIELAB color spaces.

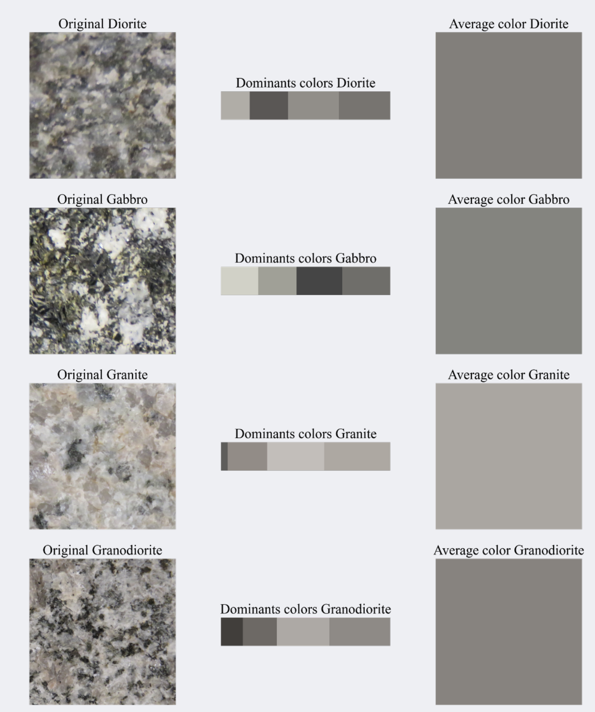

Figure 1. Dominant colors and average color of sample images

2. Training and evaluation of different machine learning models

The data of the four dominant colors were used to create and evaluate several machine learning models with the following algorithms: Logistic Regression, K-Nearest Neighbors (KNN), Decision Trees, Support Vector Machine, and Convolutional Neural Networks. The experiments were executed first with the dominant colors in RGB and then in CIELAB. The best results during validation were for the model generated with KNN trained with 283 images in the CIELAB color space. Results gave accuracy, precision, recall, and F-score average values of 93%

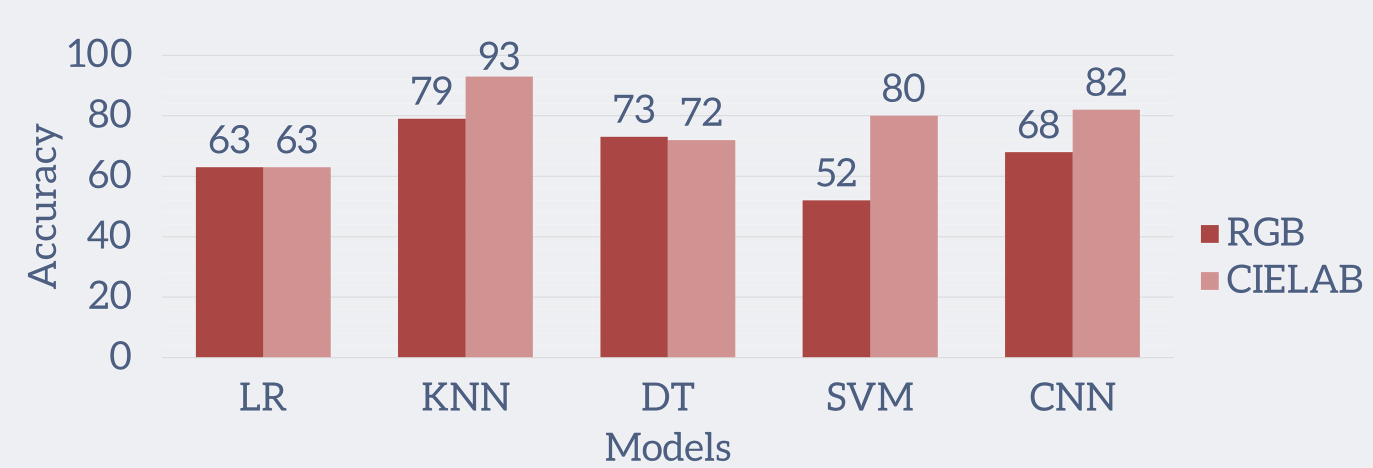

Figure 2. Accuracy results of the models trained with RGB and CIELAB color data

RESULTS

The KNN model was deployed after validation on an iOS application that classifies the extracted colors in new images of the four rock types.

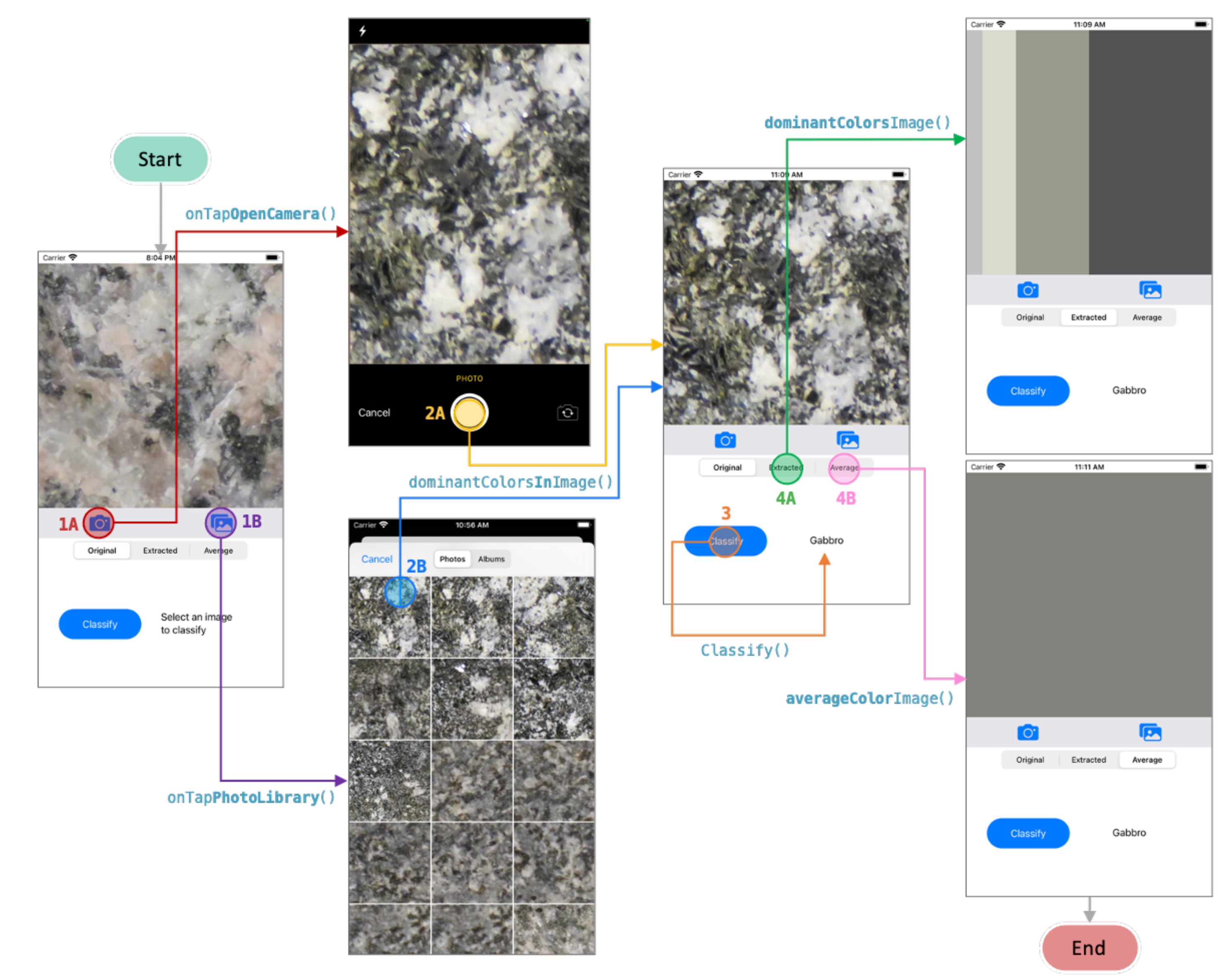

Figure 3. Application Workflow

The application was tested in the field with 34 images, and the following average accuracy results were obtained: 70% for gabbro, 28.5% for diorite, 20% for granodiorite, and 85.7% for granite.

Class	Taken images	Correctly classified	
		Images	Percentage
Granite	7	6	85.7%
Granodiorite	10	2	20%
Gabbro	10	7	70%
Diorite	7	2	28.5%
Total	34	17	50%

Table 1. Accuracy results of application evaluation

CONCLUSIONS

The high accuracy when classifying gabbro samples was because they are noticeable darker than samples of the other 3 classes. Similarly, granites were noticeably lighter.

In contrast, diorite and granodiorite share characteristics of the other rock types closest to them in the dark-light sequence; therefore, it is more difficult to automatically classify them based on their dominant colors.

FUTURE WORK

Future improvements to this work can be made to the results for granodiorite and diorite with a larger number of images covering a variety of colors per class. Furthermore, another important low-level feature in the classification of plutonic rocks is the shapes of their crystals [4]. Adding this feature to the training of machine learning models can improve the results of plutonic rocks that have similar colors as was the case for diorite and granodiorite.

REFERENCES

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