A New Approach for Image Classification Applying Reduction of Colored Keypoints

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***Abstract*— There are algorithms for feature extraction such as SIFT and Opponent-SIFT, which detect and describe keypoints. In image classification, it is common to have an image dataset. Therefore, when using an algorithm to detect and describe local features in a set of images, the number of keypoints detected by class can be disproportionate. This paper presents a novel approach to reduce the number of keypoints (and colored keypoints) in images after the feature extraction process so that computer vision techniques can be applied to image classification problems. This approach uses Zipf's Law and the Pareto Principle to conduct the new strategy to reduce keypoints. An experiment was conducted comparing four different strategies. Results are encouraging, and the proposal opens new paths for keypoints reduction and syntactical pattern recognition. The classification reached an F-Measure of 76,8%, and the computer performance (execution time) has increased from 9 to 1900 times.**

Keywords — Feature Selection, Keypoints Reduction, Image Classification, Image Processing, Pattern Recognition.

I. Introduction

The image classification task is a classical and challenging problem in the field of computer vision. The analysis to improve the process of obtaining representative features is not trivial, once the feature extraction process is an essential step for object/scene classification. However, keypoints are often using in image analysis. A consolidated and widely used algorithm for detecting and describing keypoints is the Scale-Invariant Feature Transformation (SIFT) proposed by Lowe [1], and its variation with color information descriptors is Opponent-SIFT [2]. This algorithm extracts from the image a collection of local features, describing the region around the keypoint.

When applying an algorithm like SIFT in an image dataset it is common to have different numbers of keypoints for each image. The more keypoints identified in the image, may the higher the quality of the descriptions, which may support in the classification process. Considering a dataset divided into classes, it is possible that some classes have much more keypoints detected than others do. That is common because the detection algorithms do not limit the number of keypoints per image since they analyze the importance of the keypoint based on a threshold. Thus, algorithms detect keypoints careless about the amount detected. In advance there is the problem, there is the problem of the unbalanced numbers of keypoints per class. In this way, it is possible these classes have many keypoints while others have few and may lead to a biased classification for those classes with the most significant descriptive power. Therefore, balancing the number of keypoints is essential to improve the description of power.

This work presents a new approach to reduce keypoints extracted by local descriptors algorithms such as SIFT and Opponent-SIFT. Reduction of keypoints aims to eliminate noises and redundant information, as well as equalize the number of keypoints for each class of the image from the dataset. Consequently, it reduces the execution time of the classification process. From the information reduction, it is possible to improve the quality of the model built during the image classification process, leaving it unbiased to image classification. Therefore, keypoints reduction decrease the total number of keypoints to compose the new subset of information, increasing the classifier accuracy and minimizing the complexity of the knowledge generation, such as conceptual models, automata, etc. Instead, this work makes the reduction of keypoints for images and not the dimensionality reduction of the descriptor vector created by the detection algorithm.

II. Why Reduce Keypoints?

In the image classification process, it is possible to have a large amount of information to represent images. In order to improve and optimize the classification, it becomes necessary to separate relevant features from those that are not relevant. Notwithstanding, keypoints reduction performed before the keypoint description. In practice, it is possible to imagine the greater the keypoints number, the higher the amount of information available for classification, increasing as a consequence the processing time. Therefore, keypoints reduction allows filtering according to a criterion of importance, reducing the number of possible noises or irrelevant keypoints.

Massive difference in the amount of information of each class can reduce correctness in classification from one to another. The learning algorithm can be impaired in its performance, because of the amount of data, and in the percentage of correct classification, because of redundant information can confuse the algorithm, harming it in the construction of a suitable model for the exposed knowledge [3]. When viewing the confusion matrix presented by [4], it