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Segmentation-based Euler number with multi-levels for image feature description

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Abstract

This paper proposes a new and efficient image feature descriptor using Euler Number with the help of segmentation according to given number of levelsest. The proposed Segmentation-based Euler Number for image description algorithm (SENA) works as the following steps. First, transforming the image into gray image if the image is color image; then, dividing the gray image into different sets using the given number of levelsets; next, decomposing the gray image into binary images with multi-thresh using the otsu algorithm; following, computing the Euler Number of each binary image; finally, combining the Euler Numbers, mean and variance to form the feature vector for an input image. The proposed SENA was employed to the image classification on three public available dataset (Stanford Dogs Dataset, 17 flower dataset, and Caltech 256 dataset). We compute SENA with LBP and Gabor on the Stanford Dogs Dataset, the detail classification results on 17 flower dataset is given as confusion matrix, and the result of SENA on the Caltech 256 dataset is compared with those of the recently reported. The experiments demonstrate a competitive performance of SENA for classification task.

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Keywords: Number; image feature; image segmentation; image classification; LevelSet.

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1. Introduction

Image feature description is one of the most important works for computer vision and pattern recognition. Feature description of images has wide applications, such as object detection, scene understanding, action recognition, tracking, image classification and image retrieval[1].The image classification is the basic application of image. Due to the nature of the pattern classification problem, the efficient feature description must with the power to mining the difference between different classes and keep the similarity with the same class of the image features[2]. With the efficient feature descriptor, the computer could automatically extract image feature which is able to succinctly and efficiently represent nature and visual content of an input image. In computer vision, many tasks can be considered as the task which finds the semantic gap of the image[3]. For example, remote sensing image analysis, medical image processing, intelligent traffic monitoring system, and et al. As a result, most research in compute vision area is endeavored to design discriminatory features from the image for their tasks.

In order to strike a balance between accuracy and computational speed[4], we propose a new and efficient feature description algorithm: Segmentation-based Euler Number[5] for image description algorithm (SENA). The SENA works as the following steps. First, transforming the image into gray image if the image is color image; then, dividing the gray image into different sets using the given number of levelsets; next, decomposing the gray image into binary images with multi-thresh using the otsu algorithm; following, computing the Euler Number of each binary image; finally, combining the Euler Numbers, mean and variance to form the feature vector for an input image. The proposed SENA was employed to the image classification on three public available dataset (Stanford Dogs Dataset, 17 flower dataset, and Caltech 256 dataset). We compute SENA with LBP and Gabor on the Stanford Dogs Dataset, the detail classification results on 17 flower dataset is given as confusion matrix, and the result of SENA on the Caltech 256 dataset is compared with those of the recently reported. The experiments demonstrate a competitive performance of SENA for classification task.

We evaluated the proposed SENA on three different datasets. The first dataset is NetDogs-120[6] which includes120 classes dogs, it is also called as Stanford Dogs Dataset. The second dataset is 17 flower dataset[7] which includes 17 categories of flowers. And the last dataset is Caltech 256 dataset[8] which is usually used for image classification task in the related works.

To evaluate the proposed SENA, we also compared it to commonly used image extraction methods for corresponding tasks, such as LBP (Local Binary Pattern)[9]and Gabor filter banks[10]on the NetDogs-120 dataset . And the result of SENA on the Caltech 256 dataset is compared with those of the recently reported. In our experiments, the proposed SENA has gain superior performance with respect to accuracy of image classification.

2. Related works

The image feature descriptor plays extremely important role in computer vision and image understanding[11]. It is a fundamental element in the computer vision applications which includes remote sensing image analysis, medical image processing, intelligent traffic monitoring system, and et al.. Additionally, the image feature usually was presented by statistical characteristics of image pixels or structural features basis on region distribution.

One of the most commonly used image feature descriptors may be Euler number[5] method which calculates special geometric structural properties of an input image. Euler number of a binary image is an efficient topological structure of semantics within the image. It is computed by the number of connected components and number of holes of an image. As a result, the Euler number is proven invariant to transformation, rotation, scaling, or translation.

Many algorithms have been proposed for calculating the Euler number of a binary image. According to the[12], there are at least four approaches to calculate the Euler number for an input image based on the information pixel-based. The first one is the algorithm skeleton-based which calculates the Euler number of an input image according to the number of terminal points and number of three-edge points. The second approach is based on the bit-quad information which calculates the Euler number by counting certain pixel patterns of an input image, and this method is embodied into MATLAB. The third kind algorithm calculates the Euler number E using the number of runs R and number of 8-neighbor runs O in the image, and the $E = R - O$. The fourth category method is based on the