Chapter 16
Automatic Object Classification and Image Retrieval by Sobel Edge Detection

ABSTRACT

A comparative study of ability of the proposed novel image retrieval algorithms is performed to provide automated object classification invariant of rotation, translation, and scaling. Simple cosine similarity coefficient methods are analyzed. Considering applied cosine similarity coefficient methods, the two following approaches were tested and compared: the processing of the whole image and the processing of the image that contains edges extracted by the application of the Sobel edge detector. Numerical experiments on a real database sets indicate feasibility of the presented approach as an automated object classification tool without special image pre-processing.

1. INTRODUCTION

Automatic object recognition and classification is very important and has numerous applications, such as image retrieval and robot navigation.

Rapid development of information technologies provides users an easy access to a large amount of multimedia data, for instance images and videos. Unfortunately, wide popular text retrieval techniques, which are based on keyword matching, are not efficient for describing rich multimedia context. Recently, wavelets and various methods of numerical linear algebra are successfully used for automated information retrieval and identification tasks (Tan, 2005), (Zeljković, 2007), (Berry, 1995), (Praks, 2008). Moreover, genetic programming is used as a tool for image feature synthesis and recognition (Krawiec, 2007), (Watchareeruetai, 2011). In this chapter, a comparison of modified Sobel edge detection for automatic object classification and retrieval is presented.

2. PROPOSED METHODS FOR AUTOMATIC OBJECT CLASSIFICATION

Three different methods are proposed in this chapter invariant of rotation, translation or scaling of the classified objects. They successfully perform object classification on set of three different groups of objects Dinosaurs, Mummies and Sculls represented by images taken under various rotational, scaling and zooming conditions.

Two techniques for automatic object classification are applied. Sobel edge filtered images are

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used for similarity computation in the first method and in the second method simple cosine similarity coefficient is applied on plain gray images with the goal to classify them.

The first technique implies procedure with an image converted to gray image with the extracted edges using Sobel edge detection method (Engel, 2006), (Jähne, 1999), (Farid, 2004), (Kroon, 2009), (Scharr, 2007), (Gonzalez, 2001). The idea behind this method is to significantly reduce the amount of data and filter out useless information, while preserving the important structural properties of an image and the targeted object.

Every image is processed as a two-dimensional $m \times n$ matrix image. The two-dimensional Sobel masks are applied to gray images. The Sobel operator performs a 2-D spatial gradient measurement on an image. It is used to find the approximate absolute gradient magnitude at each point in an input grayscale image. The Sobel edge detector uses a pair of 3×3 convolution masks, one estimating the gradient in the x-direction (columns) and the other estimating the gradient in the y-direction (rows). After that the magnitude of the gradient is calculated. In the next step cosine similarity coefficient (Singhal), (Garcia, 2005), (Tan, 2005), (Zeljković, 2007) is applied in order to extract the image containing the most similar object in the database.

In the second approach, color images are converted to gray scale images and processed. Then simple cosine similarity coefficient (Singhal), (Garcia, 2005), (Tan, 2005), (Zeljković, 2007) is applied as in the first method.

In the initial study, image de-noising and pre-processing by wavelet filter application is applied for both techniques. The obtained numerical results pointed out, that the application of de-noising methods does not have any influence of the proposed algorithms to perform more successful object recognition. This additionally slowed down the algorithm so it is concluded that it is the best to omit that pre-processing stage.

Different edge detection functions are applied and it is concluded, based on the obtained results that the Sobel edge detector gave the most clear and emphasized edge extracted results for the first proposed method.

In the current computer implementation of the proposed object recognition procedures, no pre-processing of images is assumed. The presented numerical experiments indicate optimistic application of the proposed techniques for object recognition and classification.

The colors of images are coded in Matlab (tm) as non-negative integral numbers and no scaling was used. The application of the proposed procedures can be written in Matlab as follows.

```
% Input:
% A … the m × n document matrix
% Output:
% sim … the vector of similarity co-
efficients
[m,n] = size(Image);
```

1. Calculate the gray image presentation for both proposed techniques:

```
Gray = rgb2gray(Image);
```

2. Apply Sobel edge detector on gray scale Image.

```
ImageSobel = edge(Gray,'sobel');
```

3. Compute the similarity coefficients between two inspected images.

```
xx = ImageSobel '*ImageSobel0;
%for the first method
%or
xx = Gray '*Gray0;
%for the second method
xx= xx/(norm(ImageSobel0)*norm(Sob
el));
sim(i) = 1-acos(xx);
```