Accelerate the Face Detection Optimization with Edge Detection and the Discrete Cosine Transform (DCT)

Javad Haddadnia, Ph.D
Hakim Sabzevari University
Iran,Sabzevar

Mojtaba Farzaneh
Hakim Sabzevari University
Iran,Sabzevar

Armin Parsian nejad
Hakim Sabzevari University
Iran,Sabzevar

ABSTRACT
This study presents a new method for accelerating and optimizing face detection, while preserving a high level of accuracy. This method uses local features that are extracted using block-base discrete cosine transform (DCT). This study uses edge detection method for face recognition with ICA algorithms. The technique used for edge detection is Laplacian of Gaussian (LOG). To find objects, face position and local information the discrete cosine transform is used. Here the main idea is edge detection and finding face position in the picture for DCT processing. Edge detection was applied for accelerating image processing. In this paper we use Cohn-Kanade AU-Coded Facial Expression Database.

Keywords
Face Detection, DCT, Edge detection, image processing, LOG.

1. INTRODUCTION
Image representation is one of the key issues in the computer vision and image processing communities. Face recognition has been an active research area over the last 30 years. Scientists from different areas of psychophysical sciences and those from different areas of computer sciences have worked on it. Psychologists and neuroscientists mainly deal with the human perception part of the topic, whereas engineers studying on machine recognition of human faces deal with the computational aspects of face recognition. Face recognition is mainly applied in the fields of biometrics, access control, law enforcement, and security and surveillance systems. Biometrics deals with methods to automatically verify or identify individuals, using their physiological or behavioral characteristics [1-6]. At first a LOG algorithm is used to detect the Edges, and then the edges of the image are used to determine the exact location of the face, when the specified location is calculated in the original picture, the coordinates are selected. Finally the image processing method (DCT) is applied for further analysis. [7]

2. LAPLACIAN EDGE DETECTION
Given an image matrix, the Laplacian of the image function is the second order partial derivatives along x and y directions. [8].

$$\nabla^2 \mathrm{g} = \frac{\partial^2 g}{\partial x^2} + \frac{\partial^2 g}{\partial y^2} \quad (1)$$

In the digital approximation of the second order, partial derivative in x direction is

$$\frac{\partial^2 g}{\partial x^2} = \frac{\partial\{g(r,c)-g(r,c-1)\}}{\partial x} \quad (2)$$

$$= \frac{\partial g(r,c)}{\partial x} - \frac{\partial g(r,c-1)}{\partial x} \quad (3)$$

$$= g(r,c) - g(r,c-1) - g(r,c-1) + g(r,c-2) \quad (4)$$

$$= g(r,c) - 2g(r,c-1) + g(r,c-2) \quad (5)$$

Similarly, the second-order derivative along y direction is given by,

$$\frac{\partial^2 g}{\partial y^2} = g(r,c) - 2g(r-1,c) + g(r-2,c) \quad (6)$$

both the approximating Eqs. (5) and (6) are centered around the point (r - 1, c - 1). Conveniently, this pixel could be replaced by (r, c). [9-11]

2.1 Laplacian of Gaussian Edge Detector
The weight distribution in a Laplacian mask evokes strong response to stray noise pixels. It indicates that some sort of noise cleaning preceded by Laplacian should provide a better result. For noise cleaning, one may employ Gaussian smoothing. Then the resultant algorithm is LOG edge operator. [9-13] The algorithm steps are given as follows:

1. Smooth the image intensity g(r,c) by convolving it with a digital mask corresponding to Gaussian function.

2. Apply the Laplacian mask on the smooth image intensity profile.

3. Find the zero crossing in the image subjected to Laplacian second derivative operator.

Mathematically,

$$g^{''}(r,c) = \nabla^2\{g(r,c) \times G(r,c)\} \quad (7)$$

which, following the rule of convolution, becomes

$$g^{''}(r,c) = g(r,c) \times \{\nabla^2 G(r,c)\} \quad (8)$$

Extracting edge points or edges by detecting zero crossing in the second derivative still suffers from the problem of false alarm i.e., a non-edge pixel may be marked as edge pixel. This is because even a small nonlinear variation in intensity profile gives rise to zero crossing in second-order derivative. The problem may be surmounted by considering both first- and second-order derivatives. In that case, an edges is said to be present if there exists a zero crossing in second. [9-13]

The input facial images and edge-detected face images using LOG is presented in Figure 1.

3. DISCRETE COSINE TRANSFORM
The discrete cosine transform (DCT) is a useful tool in signal processing for frequency analysis. Its results correspond to the frequency components in an (signal) image - i.e., the low and high frequencies are arranged in DCT components. The DCT represents a sequence of finite pixel elements in terms of the sum of cosine functions oscillating at different frequencies. [14-16] For a 2D image of size M*N, the DCT-II is defined

as:

$$C(a,b) = \alpha(a)\alpha(b)\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)C_x^M(a)\,C_y^N(b) \quad (9)$$

with its inverse transform:

$$f(x,y) = \sum_{a=0}^{M-1}\sum_{b=0}^{N-1} \alpha(a)\alpha(b)C(a,b)C_x^M(a)\,C_y^N(b) \quad (10)$$

Where $C_k^P(h) = \cos\left[\frac{\pi(2k+1)h}{2P}\right]$ For both equations (9) and (10), $\alpha(a)$ and $\alpha(b)$ are defined as $\alpha(a) = 1/\sqrt{M}$ if a=0, otherwise $\alpha(a) = \sqrt{2/M}$ and $\alpha(b) = 1/\sqrt{N}$ if b=0 otherwise $\alpha(b) = \sqrt{2/N}$ if a=0 and b=0 then C(0,0) is $(1/\sqrt{M})(1/\sqrt{N})\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)$ which is an average value of the sample sequences. Therefore, the suppression is on the DC and a first few AC components and is defined as a divisor matrix Q with: [14-16]

$$Q(0,0) = \beta_0$$

$$Q(0,1) = Q(1,0) = \beta_1$$

$$Q(0,2) = Q(2,0) = Q(2,2) = \beta_2$$

And

$$Q(0,3) = Q(3,0) = Q(2,3) = Q(3,2) = \beta_3$$

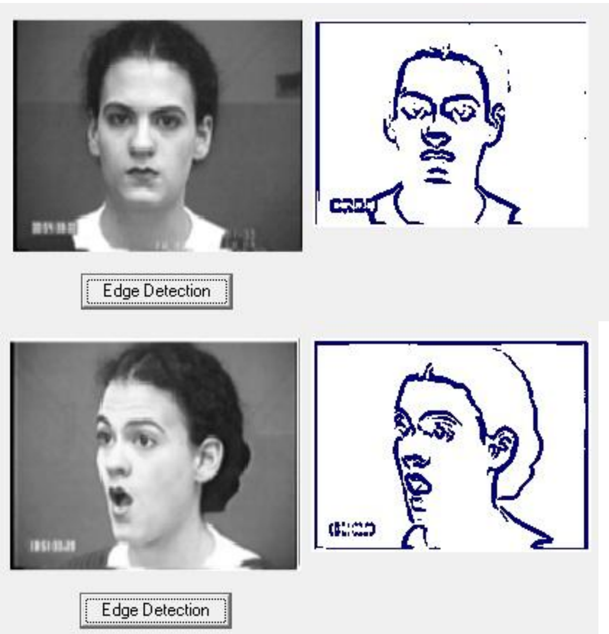
with all other Q(a,b)s set to 1, where
$\beta_0 \in [0.85, 1.3]$, $\beta_1 \in [0.5, 0.7], \beta_2 = \beta_1 + 0.1$

and $\beta_3 = \beta_2 + 0.1$ We define the quantized DCT face image as:

$$D(x,y) = iDCT\left(\frac{DCT(f(x,y))}{Q(x,y)}\right) \quad (11)$$

where DCT and iDCT are the discrete cosine transform and its inverse as defined in equations (9) and (10). Using DCT in conjunction with TV is useful insofar as the facial features are enhanced while the illumination variations are suppressed. [6],[17-20].

4. FIGURES/CAPTIONS



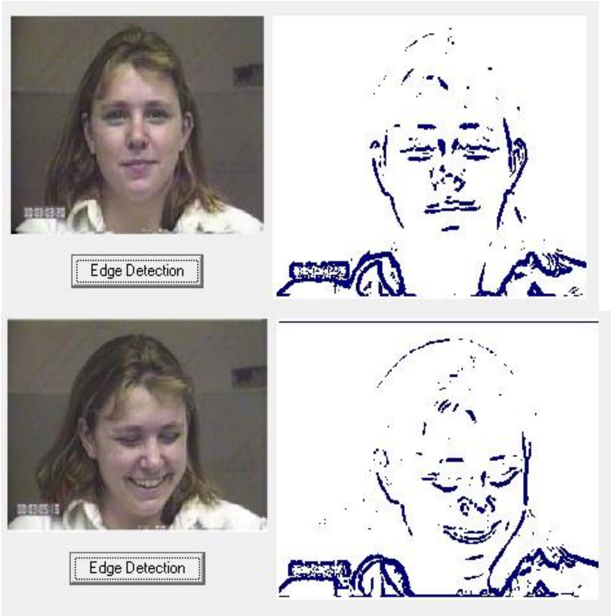


Fig 1: Edge Detection

Figure1 is Input face images and Edge detected images by LOG operator.

Fig 2: Our algorithm (use Edge Detection and DCT)

5. RESULT

Whit Analysis of sections 2 and 3 of the image Face detection and DCT, we recognize the Control and reduce processing time. The results of this study are in Table 1

Table 1.Recognition performance (%)

Graphics	Accuracy	Delay	Process Result
DCT	83.3	More than our	True
OUR	100	Fast	True

6. CONCLUSION

As discussed above, through the use of the proposed method in which the focus is on edge detection and face localization, determining the coordinates of face and selecting it from the original image, the processing time and size of the mathematical calculations are noticeably reduced. Regarding the sections two and three in this paper, the mathematical algorithm for edge detection is more compact and faster in this method in comparison with the DCT method. This method reduces the image coordinates and only selects the face from the image. As a result processing images needs much less time and is fulfilled much faster. This algorithm Accelerate the Face Detection Optimization with Edge detection and The Discrete Cosine Transform (DCT).

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