MODELING IMAGE RECOGNITION BASED ON BINARY SIMILARITY MEASURE

Yahia S. Al-Halabi
Princess Sumaya University for Technology
Computer Science Department-Amman-Jordan
E-Mail: yahiah@psut.edu.jo , yahia_1111@yahoo.com

ABSTRACT

Matching based on Moiré pattern is a well known method for image recognition. Image recognition is one of the interesting fields of study. There are many methods for image recognition. Some uses images subtraction and others use the wavelet technique which is a new topic used in many fields and applications. This paper, represent a model image recognition by mean of Binary similarity measure. Matching technique used in this model differs from conventional matching, in such a way that the matching points are not compared under a search task, but rather under a circular pattern resulting from superimposing two images under investigation. Results obtained, prove that this technique introduced by the modified Moiré pattern is very useful and can be used in many applications. It is accurate, fast and can be performed in minimum space for storing data. It is applicable in image recognition and it is more secure in image transmission.

Keywords: *Image recognition, high pass filtering, binarization, Moiré pattern, Wavelet*

1. INTRODUCTION

Computing similarities between images are the basic task required for image classification and matching [9]. Binary similarity measure based or Moiré pattern is studied by [9, 10] using the difference of intensity:

$$D=\sum_{x=1}^{m}\sum_{y=1}^{n}\left|I_1(x,y)-I_2(x,y)\right| \quad \textbf{..........(1)}$$

where I_1, I_2 are image intensities for two **mxn** regions. Conversion of gray level images to images formed by random dots [9] is one of the requirements for successful application of the Moiré based method in image matching. Setiawan and Przemyslow [10], suggested that in order to apply matching algorithm, gray levels must be transformed to random dot like patterns and then rotated and superimposed. Transformation to dot pattern is done using a high pass filtering technique (3×3 Laplacian) and then binarizing the image. Superimposing two dot images, in which one has been retorted by 3 degrees results in appearance of concentric circles only in the case of a match. They used Hough technique to detect this pattern.

Wavelet transform [10-13] for multi-resolution local analysis or signals has been proved very effective. It has been successfully applied to image compression, signal detection such as speech, seismic, biomedical and other signals. The grand challenge of vision, particularly image recognition, lies in constructing a unified framework for modeling image content with appropriate semantic abstraction levels [1-8] and [12-13].

The latest research in this field was implemented by [9-11], by using Moiré Patterns for locating the fixed point. They suggested computing a binary similarity measure for two digital images. When two identical images are superimposed, with one of them rotated beforehand, circular Moiré patterns are exhibited. The circles with the center at the fixed point predicted by the Brouwer's theorem can be observed visually or detected using a Hough technique. The proposed algorithm by [8,9] depends strongly on the fixed point generated. This fixed point will be center of all circles.

Theoretically, this is not always the case. Fixed point, if exists might not be unique, and also it might not exist. This will make the proposed algorithm to be applicable only, for special and limited applications. Accordingly, we will follow the work done by [9], and apply different technique for determining what we call: the fixed point's percent of the generated circles. This can be also applied in image security. It is a matter of coding and decoding an image. So if we rotate an image by θ at a specified centre and sent it for any destination, then the receiver can't see the actual image or source correctly unless we tell him the rotation angle θ and the centre of rotation.

2. BACKGROUND

Moiré patterns are images in gray scale converted into random dot through a process called Binarizing. This pattern represents the original image by 5% of the pixels of the original image. It has the characteristic that each image has its own unique random dot image. This technique gives a new method for image recognition by comparing only the random dot images. This means that comparing 5% of the pixels are enough to perform image recognition. Binarizing is the process of converting an image (gray) that has pixels values [0..255] into an image that has values only [0 or 1] or [0 or 255] to represent each pixel. To perform binarizing and get 5% random dot image, one can apply thresholding or bit slicing.

3. BINARIZING USING THRESHOLD

Image can be considered as a two dimensional array. Each element has a value 0 up to 255. Initially, apply spatial filter on the image as follows [10]:

G(x, y) = F (f(x), y) …….. … .. (2)

where f(x, y) is the original matrix, G(x, y) is the random dot matrix and F is the filtering process. Filtering is typically performed on an **mxn** sub image area (window) at image location (x, y) . The window is moved from pixel to another starting at the top left corner, and filter is applied at each location (x, y) to yield G at (x, y).

The purpose of filtering process is to convert image to fewer points than original one and to make it as an input to the next step which is thresholding.

There are many filters which can be applied such as : Highpass, Laplacian-1 and Laplacian -2

$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix} \quad \text{Highpass}$$

$$\begin{bmatrix} 1 & -2 & 1 \\ -2 & 4 & -2 \\ 1 & -2 & 1 \end{bmatrix} \quad \text{Laplacian-1}$$

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix} \quad \text{Laplacian-2}$$

User can select the suitable filter which fit his images. Although Laplacian-2 was used in many cases, but in our case, it is noticed that highpass filter is preferable.

Threshold is the process of converting the filtered image into two value images greater than or equal threshold value of 255, and all points with values less than threshold take value zero. Since the type of filter selected depends on the type of image, then it is noticed that the value of the thresholds depends on the type of filter selected. In our case, the value of 253 seems appropriate.

4. IMAGE RECOGNITION

One of the advantages of using dot or moiré pattern in image recognition is that it allows getting only 5% of the original number of pixels. For recognition, we only able compare those 5% saved locations (x_i, y_i) , and the comparison is performed by comparing the existence of these locations (x_i, y_i) in both images under study. For multi - comparison, it will be also helpful to exclude images with number of locations (x_i^1, y_i^1) less or greater than the number of locations (x_i, y_i) in the original image.

5. CONCLUSIONS AND DISCUSSIONS

We used in this paper different methods for detecting concentric circles, other than the circle detection algorithm used by [9]. The method applied by [9, 10] looks at the fixed point in which they assumed that it is exist, unique and it is the center of all concentric circles. Theoretically, this is not always true. Existence and uniqueness of a fixed point for any function is restricted by many constraints. For this purpose, we will generalize this by applying other technique called 'Rotational' technique. We mentioned in the introduction the use of rotation in image security. It is a matter of coding and decoding of an image. If sender sent an image rotated by an angle θ around a specified center, then the receiver can only recognizes the image if he only informed with the angle of rotation θ and the center of rotation. To perform this, find the points in the superimposed image that has the arc of the same angle from the same center. Such points can be obtained by applying OR operation on both images (image resulted from rotation and the image under consideration for recognition). Rotation can be applied by multiplying the position of the pixel by rotation matrix, as follows:

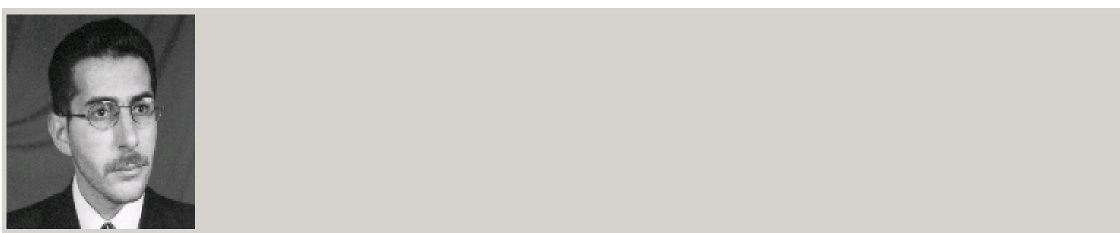
Rotation- point[x y] =

Original-point[x]* $\begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$

………………… (3)

The main procedure for recognition is to count all points in the superimposed image (count- 1), then search for the arcs and exclude all points that represent. Finally, count the points which still exist in the superimposed image (count-2). By dividing coun-2 over counter -1, we get the percent of all points satisfied the fixed points. The most proper image recognized is the one with high fixed point percent. Figure 1 shows the different stages applied for image recognition for a sample of four images in a database of images. Figure 2 shows the results of image recognition by comparing each image in the source with the other sample database images. Results obtained by rotation with an angle of 90 degrees recognize the image with a percentage of 100%.

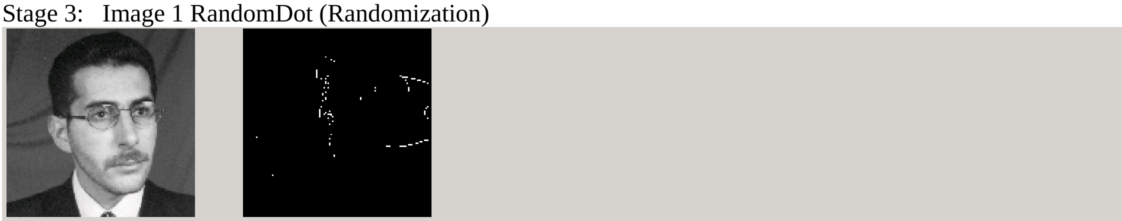
The sample output is presented for comparison only. The package implemented is tested against 1000 image saved in the university database and the results were outstanding.



Stage 1: Loading Image 1

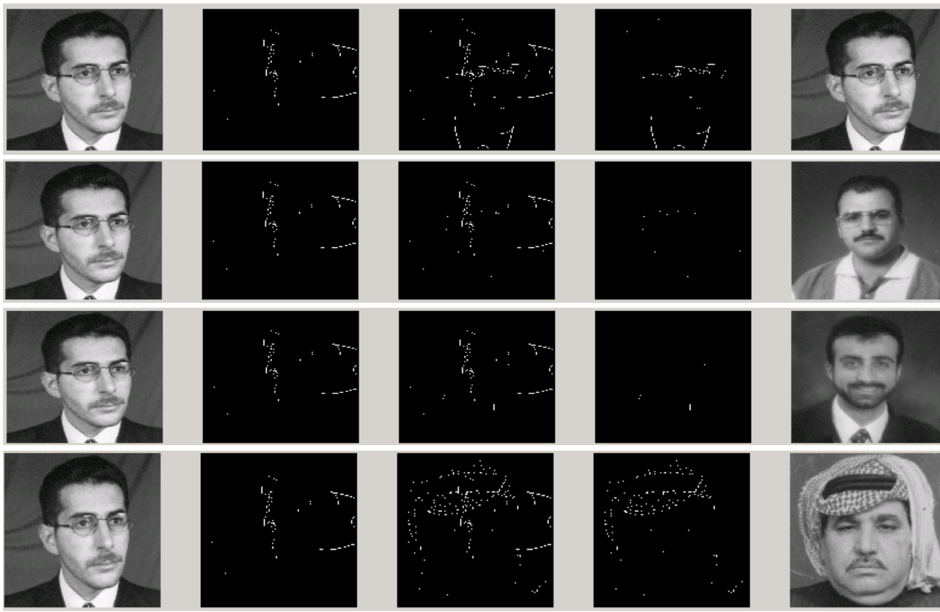
Stage 2: Image 1 filtered

Stage 3: Image 1 RandomDot (Randomization)



Stage 4 Image 1 Rotated with an angle 90 degrees

Stage 5 to 8 : Superimposing images1 with images 1 up to 4:



stage-5

stage -6

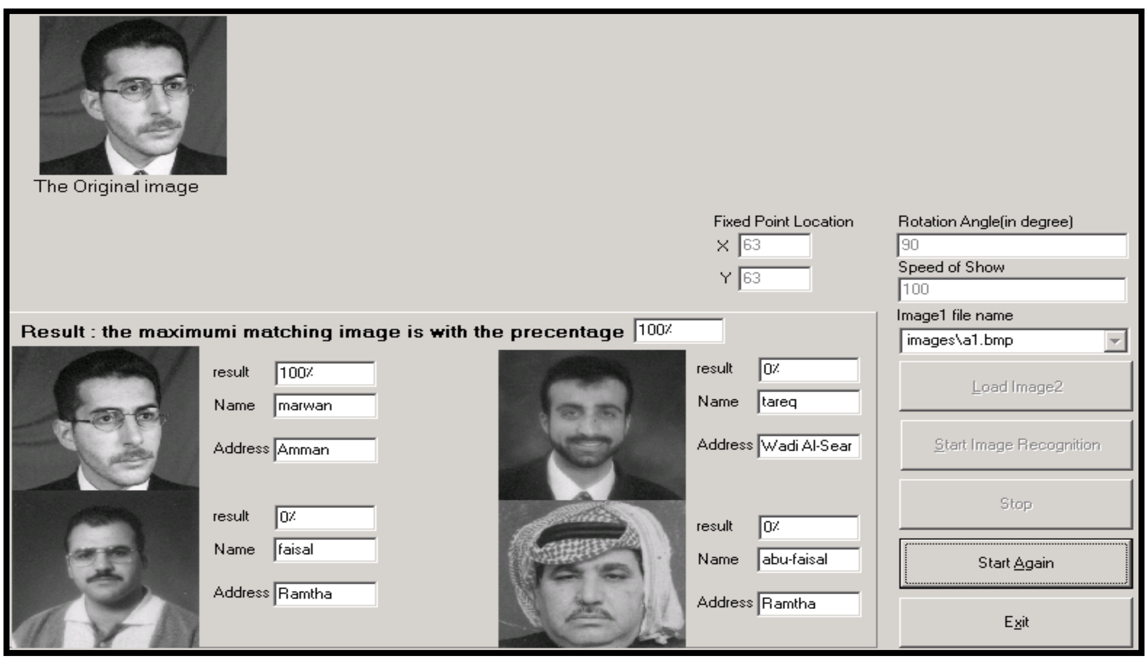
stage -7

stage-8

Figure 1. Stages applied for Image Recognition

<u>Sample Testing:</u>

Testing with Image1



Testing with Image 2

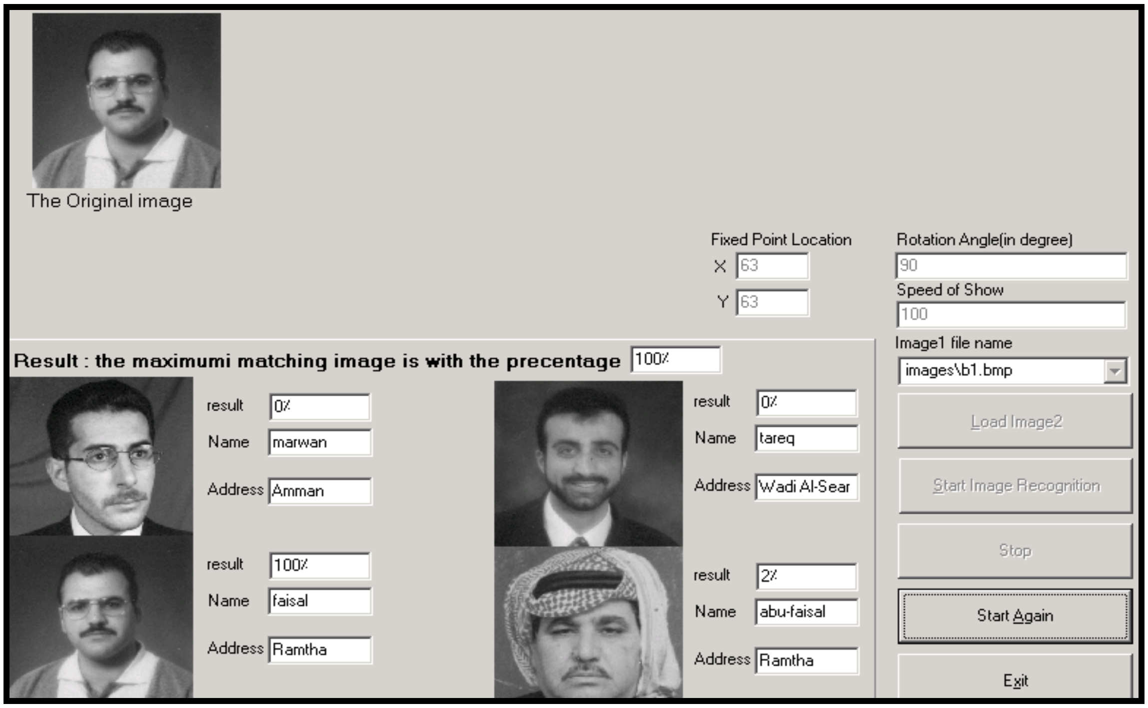


Figure 2. The Result of Image Recognition**.**

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Profesor Yahia AL-Halabi

received his Ph.D Degree in Computer Science in 1982, from Clarkson Univesity, Potsdam,NY, USA and his Ms.c degree in Simulation from the University of Jordan - Hashemite Kingdom of Jordan . Since 1982, he served as professor of computer Science, Chairman of the computer, Director of Computer Center Department at the University of Jordan, Dean Of faculty of Art and Sciences at Amman Private University, Dean of Faculty of Computer Studies at Arab Open University – Kuwait headquarter office. He joined Princess Sumaya University for Technology in 2005 and continues he research in image processing and simulation. He is appointed recently as Dean of King Hussein School for Information Technology at Princess Sumaya University for Technology.