

## Isolated Arabic handwritten words recognition using EHD and HOG methods

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### ABSTRACT

Handwriting recognition is a growing field of study in computer vision, artificial intelligence and pattern recognition technology aimed to recognizing texts and handwritings of hefty amount of produced official documents and paper works by institutes or governments. Using computer to distinguish and make these documents accessible and approachable is the goal of these efforts. Moreover, recognition of text has accomplished practically a major progress in many domains such as security sector and e-government structure and more. A system for recognition text's handwriting was presented here relied on edge histogram descriptor (EHD), histogram of orientated gradients (HOG) Features extraction and support vector machine (SVM) as a classifier is proposed in this paper. HOG and EHD give an optimal features of the Arabic hand-written text by extracting the directional properties of the text. Besides that, SVM is a most common machine learning classifier that obtaining an essential classification results within various kernel functions. The experimental evaluation is carried out for Arabic handwritten images from IESK-ArDB database using HOG, EHD features and proposed work provides 85% recognition rate.

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## 1. INTRODUCTION

The handwriting recognition is the old dream of all those who needed entering data into a computer. It dates back more than thirty years. Today, there are several areas where the handwriting recognition manuscript is eagerly awaited, such as automatic sorting of mail, automatic processing of administrative files, survey forms, or the registration of bank checks. These applications clearly demonstrate the specifics of the field of recognition of handwriting compared to that of the optical character recognition (OCR: optical character recognition) regarding printed or typewritten. It is also necessary to distinguish online recognition (on-line) writing manuscript, which had the character of the interface between man and computer (a special pen connected to the machine and only works on a sensitive tablet), recognition offline (off-line). Only the offline recognition will be considered in this work [1], [2].

In order to evaluate the recognition systems, a standard database for text handwriting are needed, such as AHDB [3], IFN/ENIT [4], and IESK-ArDB [5], which performing a crucial function in off-line recognition of handwriting. Furthermore, the system of text recognition typically has various phases which are segmentation, preprocessing, acquisition, classification and feature extraction. Despite that some investigators are combine or eliminate those phases [6].

## 2. PROPOSED WORK

In this section, the major structure of the text recognition method is presented. A text image is fed as an input to the system and the output will be an editable text. The created program for analyzing and recognizing the handwriting text comes with several main steps. The accuracy and performance of the recognition program depends on each of these major steps. At the beginning, the provided images fed as an input is grouped altogether to be as collection of documents which will go through multiple processing steps as shown in Figure 1. The proposed system includes multiple steps which are; pre- processing, features extraction, categorization and recognition. Each of these steps works together to enhance the recognition accuracy.

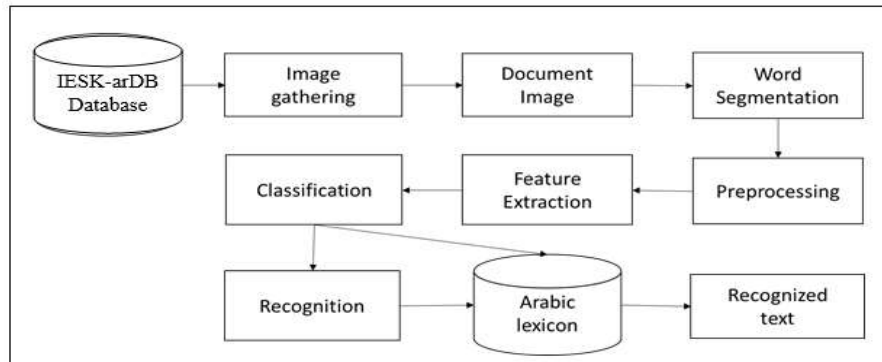


Figure 1. The proposed system

### 2.1. Word segmentation

Segmentation is an important step in several applications especially recognition system. It can be defined as a dismantle step of texts image, pseudo images of personal symbols. Writing in Arabic is cursive as a result of that, words and sub words are detached with spaces [7], [8]. For that, the boundaries of words usually characterized by a space. Based on that, the distances for each couple of successive sub words are measured. Usually, the spaces between sub words are smaller than the spaces between words, consequently, segmentation for the words could be applicable when make a comparison between this distance versus an appropriate threshold., minimal classification error for bayesian standards are utilized to find such required threshold [9], [10]. Figure 2 shows the example of input data image to the system.

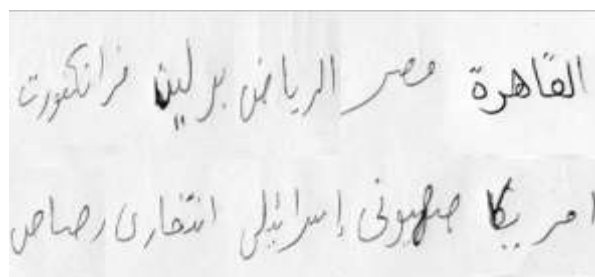


Figure 2. Input document image

After applying the segmentation method, there will be several segments that represent the text. Each segment represent one word which used as input for the rest of stages. Figure 3 illustrate the output of the segmentation method.



Figure 3. Word segmentation

**2.2. Preprocessing**

Preprocessing stage is a common and significant step not just for text recognizing system but for all image processing methods [11], [12]. At this stage, the image is treated to be ready for the next level of analyzing. In this phase, noise reduction achieved with keeping the significant data untouched. The noise can be according due to several reasons such as errors in documents formatting or lighting conditions. Preprocessing is very important stage includes sub-multiple steps to insure high accuracy and high rate of recognition. Grayscale image is the input data to the text recognition technique that Arabic words are part of it. These data images are converted during this step to a binary image by adopting a method of thresholding. The reason behind utilizing Thresholding is to minimizing image dimensions to simplify the way to process it [13], [14]. In the suggested work method Otsu method was used for threshold purpose as shown in Figure 4.



Figure 4. Image thresholding. (a) Gray images, (b) Binary images

During thresholding, some noise pixel might be existed within text image. And these can be considered as unwanted noise that should be eliminated of the text image because at the end these noises could act in negative way by creating irregularity on the text that affect image quality to filter these noises, an algorithm of noise removal is used to overcome such problem. The work mechanism of such algorithm to reduce the noise is to remove any isolated pixels in one hand and to prohibit holes formation in other hand. Double threshold were applied on Arabic text in binary images, the noise pixels above and under the threshold's values will be removed by setting their values to zero. The suggested algorithm to remove the noise uses T1 and T2 which are thresholds values. These values are gained empirically and determined after conducting several tests on some images. The NR algorithm eliminates all the unwanted pixels of the binary images depending on these thresholds [15], [16].

The third step in the suggested process is to eliminating the black or dark spaces surrounding the text in the background of the images. These black spots around the text are represented by zero value and can have negative impact on the extraction process of features and give inefficient results. The suggested method to remove the black spots is depends on counting the black pixel numbers from all directions of the image. For each sides of the input image, nearest ink pixel of the handwritten will be included. And this generates four boundaries which formed by four points belong to the bounding window. Ultimately, by using these four

values the black spots around the window could be removed [17]. After applying the third step the output image as shown in Figure 5.

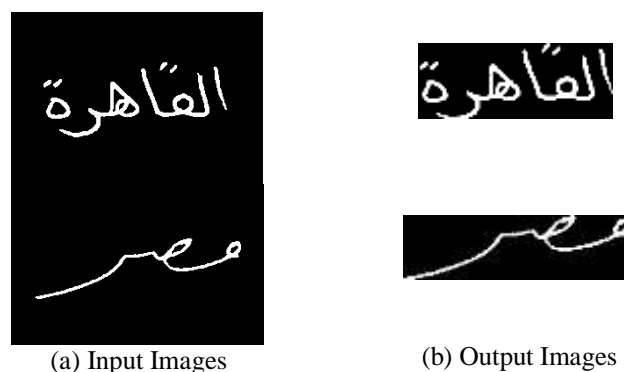


Figure 5. Black space elimination

Normalization of image is considered the final step in the preprocessing stage. The text can be written in various sizes and styles. Therefore, the images should be set in unified size, and this measurement ease and facilitate the extraction of feature process. Specialists use normalization to establish a unified size for the handwriting image. By doing this, the feature extraction will be enhanced and sustain the classification step. Here in this research the images were normalized to size of 128X 128 pixels [18].

### 2.3. Feature extraction

At this stage, the main goal to achieve is to select the most reliable and relevant features of the handwriting image. This phase is considered a vital step which effects directly on the classification results and on the total consuming time of the computational procedure. Namely, the right and well selected features will be reflecting positively on classification process and make it faster and more efficient but in one condition which is the adopted feature should be in harmony with the classifier procedure and appropriate to the application as well. The suggested technique used in applying feature extraction were edge histogram descriptor (EHD) and histogram of oriented gradient (HOG) [19].

#### 2.3.1. Edge histogram descriptor (EHD)

This method suggested for MPEG-7 [20], [21] comprises the local delivery edge in the image. That means, this method is designed to retain the histogram in small size to ensure highest metadata storage efficiency. Normative histogram sides of MPEG-7 is planned to include the board place distribution within eighty trays. These trays of histogram are identical and semantic standardization for histogram's edge descriptor standard of MPEG-7. Nevertheless, with just localized histogram the percentage of fully representing global entities of distribution board is reduced.

Images divided into sub-pictures of 4x4 locate the dispensing edge to a specific area of the input image as shown in Figure 6. Then, edge histogram was produced for each sub-image, to represent the dispensing edge in the sub-image. In addition, the sub-images can be classified into tiny blocks named (blocks of image) to define the different edges types.

Five types of edges are illustrated in the descriptor edge of the histogram, as shown in Figure 7. Five edges available and can be divided into four directional edges and the fifth edge is non directional. These directional edges consist of horizontal, vertical, diagonal and 45,135 edge degrees. From images in window blocks, these edges of directional feature are gained while the non-directional edge is extracted from block image with random and lack of directionality board

In addition, the number of edges was counted after extraction from the edge of the image blocks for all types of edges in each sub-image. Five histogram bins is defined for all sub-image, because there are five different edges. Hence, as sixteen is the product of four sub-image repeated four times, then eighty will be the result of sixteen times repeated based on five boxes on sides of the histogram. The definition of semantic trays represented in Figure 8 is obtained after scanning the sub-images by using the order mentioned in figure one.

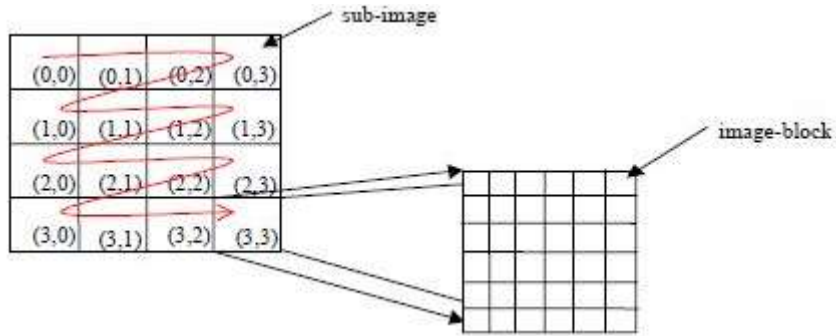


Figure 6. Sub-image and image-block

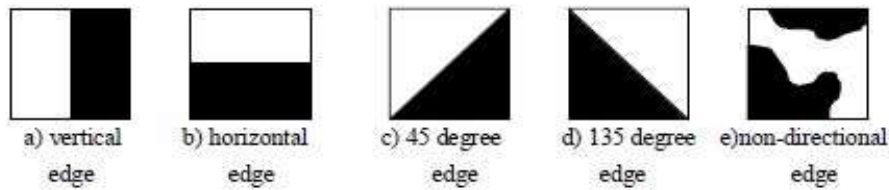


Figure 7. Five types of edges

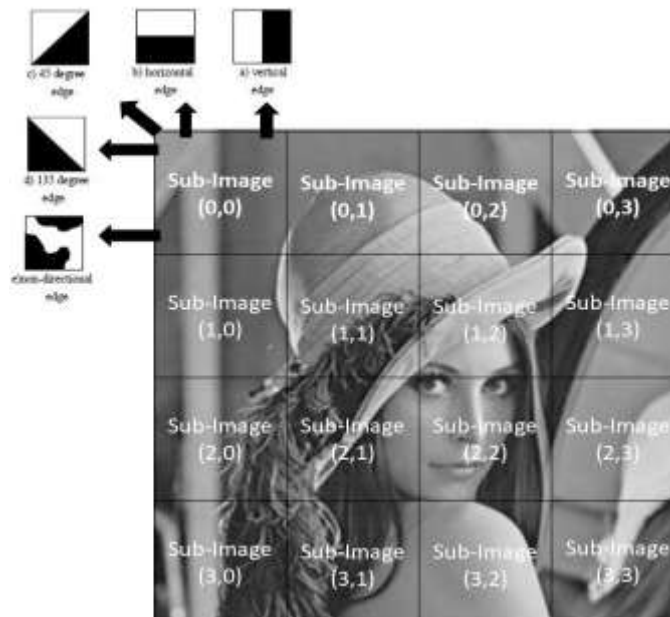


Figure 8. Applying filter on each local sub-image

**2.3.2. Histogram of oriented gradient (HOG)**

Triggs and dalal were the first who suggested the (HOG) to be used in detection of the human body. Since then the use of this descriptor has been expanded to participate in recognition systems and computer visions. HOG is considered as a manifestation descriptor due to the ability to recognize and locate the orientation degree of the gradient. Before applying the HOG descriptor, two preliminary steps are required which are, converting the binary image to grayscale and then apply filter by using the suggested filter of boundary detection mask as shown in Figure 9. By implementing these two preliminary steps a better recognition is obtained comparing with robert and sobel’s filters [22].

$$\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \quad \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$$

Figure 9. Filter for edge detections

The estimated value of the vertical and horizontal at each point for directions and gradients is presented in (1) below to obtain the approximated value for the norm of the gradient:

$$g = \text{sqrt}(g_x^2 + g_y^2) \quad (1)$$

Where  $g$  is the magnitude of the gradient

$$D = \tan^{-1}(g_x / g_y) \quad (2)$$

Where  $D$  is the direction of the gradient.

Squared cells were used here  $6 \times 6$  with bin value equal to 10 directions to divide the input image when using the HOG. After that, edge or gradient directions of histogram were calculated depending on the focal of the variations. As a result of doing this, the feature vector is represented by set of feature which their overall size is the product of:  $9 \times 6 \times 6 = 324$ .

## 2.4. Classification

There are different types of classification that can be applied on recognition of text. The most popular and most important one is the support vector machine (SVM). Classification step plays a crucial role in recognition pattern system by making a decision on a class form related. The important purpose of this step is design a procedure (form) to unidentified class established in advance from the depiction in parameters form.

### 2.4.1. SVM classifier

SVM [23], [24] was developed in the late of 1990 by cortes and vapnik as a machine for statistical purposes. In no time they became very famous in the field of classification especially in mining data and application in recognition of patterns and they acquired remarkable rate of classification. This machine is based on the calculation of core functions and were very popular for regression and classification applications [25], [26].

SVM normally applied on RBF, polynomial, linear and sigmoid kernels. A classification of multi class SVM was used in the suggested method but with disparate kernels of 1) RBF 2) sigmoid 3) polynomial 4) linear and the results were very accurate in terms of patterns recognitions.

## 3. EXPERIMENTAL RESULTS AND DISCUSSIONS

This research was accomplished by using R2015 version of Matlab. IESK-arDB dataset 4000 handwritten word images. The dataset has been divided into two parts 70% for training and 30 % for testing the system performance. As a result, to verify the system efficiency different random runs with 2800 images for training and 1200 images for testing have been used. The experimental results show that the proposed system achieved high level of accuracy with 85% in terms of pattern recognition.

In (3) was used to enhance and simplify the computing process by adopting feature normalizing (scaling) to ensure that the range would be between  $[-1, 1]$ . In [3] explains as (3):

$$A' = (A - \min(A)) / (\max(A) - \min(A)) \quad (3)$$

$A$  represent the original feature value and  $A'$  represent the normalized value.

In the classification part, the SVM classifier has been implemented and it shows high level of accuracy. In fact, there are two parameters in SVM classifier that determine how efficient the classifier is worked. These parameters are gamma ( $\gamma$ ) and the  $\cos(c)$ . Besides, after implementing numerous tests, the most valuable outputs for  $c$  and  $\gamma$  were 8 and 0.0625 respectively.

To verify the system performance, the proposed system has been compared with the state of the art systems by using same dataset. Based on Table 1, the proposed system shows high level of accuracy when it compared with the state of the art systems.

Table 1. Recognition accuracy comparison

System	Features Method	Accuracy
Elzobi [17]	Gabor	74%
Jinying [18]	Gabor, GSC	84.3%
El Moubtahij [26]	local densities, statistics	80.26%
Proposed System	HOG, EHD	<b>85%</b>

#### 4. CONCLUSION

In this paper, an efficient and accurate handwriting text recognition system has been proposed 70%, and 30% of the data base were used for training and testing respectively. The most accurate results came from SVM polynomial kernel. The most reliable output accomplished relying on effective features descriptive methods EHD and HOG. When comparing the recognition rate of both the existing and the suggested systems, one can found that the suggested system provided better and more promising results than the existing one.

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