English Capital Letters Recognition Depends On Computing The Seven Moments

Prof.Dr. **Abdul Monem S. Rahma *** **Msc.Ikhlas F.Nassir ***

Abstract

There are many digital images for printed documents and the research will continue to arrive to the best algorithm for identifying the English characters symbols and those letters more frequently. There has been a great area for these researches. This research uses an image that contains single character each. The proposed recognition process begins by converting that image into frequency domain by applying discrete cosine transform(DCT) , computing the seven moments for this image as a features for that character and then building a database which depends on these features for recognition task. The aim of this research is to prove that each capital letter has been written with the same font and size but in different directions is also one of the English capital letter because it has the same seven moment's values.

Keywords: Discrete Cosine Transform, Rules of moments, and Digital image contains single English letter .

***Computer science Department, University of Technology/Baghdad**

1. Introduction

The dealing with the digital document image has been increased in the last years and consider as education and management resources for more applications. it cannot deal with the content of the digital image directly because it is complete digital image .For accessing to the text of the document it must recognize its content and spilt it into letters and symbols that the document has been written.

Object recognition is a task performed daily by living beings and is inherent to their ability and necessity to deal with the environment. It is performed in the most varied circumstances - navigation towards food sources, migration, identification of predators, identification of mates, etc. - with remarkable efficiency. [1].

The development of methods capable of emulating the most varied forms of object recognition has evolved along with the need for building "intelligent" automated systems, the main trend of today's technology in industry and in other fields of activity as well in these systems objects are represented in a suitable way for the type of processing they are subject to. Such representations are called *patterns.* In what follows we use the words object and pattern interchangeably with similar meaning.[2].

Pattern Recognition **(PR) is the scientific discipline dealing with methods for object description and classification.**

Since the early times of computing the design and implementation of algorithms emulating the human ability to describe and classify objects has been found a most intriguing and challenging task.

Pattern recognition is therefore a fertile area of research, with multiple links to many other disciplines, involving professionals from several areas [3].

2. Classification task

When evaluating the similarity among objects it resorts to ***features*** **or** ***attributes*** **that are of distinctive nature. Imagine that it wanted to design a system for discriminating character.**

In order to obtain a numeric representation of the color feature it may start by splitting the image of the objects into red-green-blue components. Next it may, for instance, select a central region of interest in the image and compute, for that region, the discrete cosine transform (DCT) to appear the characteristics and compute the moments to the pixels resulted from (DCT) in the range 0; 0=no color [4].

3.Discrete Cosine Transform (DCT)

Discrete Cosine Transform (DCT) is the basis for many image and video compression algorithms, especially the baseline JPEG and MPEG standards for compression of still and video images respectively.

The two-dimensional DCT can be computed using the one-dimensional DCT horizontally and then vertically across the signal because DCT is a separable function.

The *two-dimensional forward discrete Cosine transform* (2D FDCT) of a block of *M* x *N* samples of a two-dimensional signal *F (z ,* y) is formulated as

$$F(u,v) = \frac{2}{\sqrt{MN}} C(u)C(v) \sum_{x=0}^{N-1} \sum_{y=0}^{M-1} f(x,y) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \cos\left[\frac{\pi(2y+1)v}{2M}\right] \quad \text{... (1)}$$

For u = 0 , l , . . . , *N* - 1 and
v = 0,1, . . . , *M* - 1, where

$$C(k) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } k = 0 \\ 1 & \text{otherwise.} \end{cases}$$

The function f(x,y) represents the value of the x th sample in the y th row of a two-dimensional signal. *F (u,* v) is a two dimensional transformed coefficient for *u* = 0,1,. . . , *N* - 1 and *v* = 0,1,. . . , *M* - 1.

The *two-dimensional inverse discrete Cosine transform* (2D IDCT) is computed in a similar fashion [5]. The 2D IDCT of *F (u,* w) is formulated as

$$f(x,y)=\frac{2}{\sqrt{MN}}\sum_{u=0}^{M-1}\sum_{v=0}^{N-1}C(u)C(v)F(u,v)\cos\left[\frac{\pi(2x+1)u}{2M}\right]\cos\left[\frac{\pi(2y+1)v}{2N}\right] \quad \text{... (2)}$$

4. Moment invariants

Moment invariant is **to use region-based geometric moments that are invariant to translation and rotation. It identified seven normalized central moments as shape features, which are also scale invariant.**

Let F (x, y) denote an image in the two-dimensional spatial domain.

Geometric moment of order p + q is denoted as

$$m_{p,q}=\sum_{x}\sum_{y}x^{p}y^{q}F(x, \quad \text{... (3)}$$

for *p , q* = 0 , 1 , 2 , . . N The central moments are expressed as:

$$x_c = m_{1,0} / m_{0,0}$$

$$y_c = m_{0,1} / m_{0,0}$$

Where $m_{1,0}$ mentioned in Eq. (3) and *(xc,* yc) is called the center of the region of object. [6] .Hence the *central moments,* of order up to 3, can be computed as :

$$m_{0,0} = m_{0.0}$$
$$m_{1,0} = 0$$
$$m_{0,1} = 0$$
$$m_{2,0} = m_{2,0} - c_c m_{1,0}$$
$$m_{0,2} = m_{0,2} - g_c m_{0,1}$$
$$m_{1,1} = m_{1,1} - g_c m_{1,0}$$
$$m_{3,0} = m_{3,0} - 3c_c m_{2,0} + 2m_{1,0} c_c^{\,2}$$
$$m_{1,2} = m_{1,2} - g_c m_{1,1} - c_c m_{0,2} + 2g_c^{\,2} m_{1,0}$$
$$m_{2,1} = m_{2,1} - 2c_c m_{1,1} - g_c m_{2,0} + 2c_c^{\,2} m_{0,1}$$
$$m_{0,3} = m_{0,3} - 3g_c m_{0,2} + 2g_c^{\,2} m_{0,1}$$

The *normalized central moment, denoted* $h_{p,q}$ ***,*** **are defined as:**

$$h_{p,q} = m_{p,q} / m^{g}{}_{0,0} \qquad \textbf{... (4)}$$

Where

$$g = p + q/2 \qquad \textbf{... (5)}$$

For *p* + q = 2, 3, a set of seven *transformation invariant moments* can be derived from the second- and third-order moments as follows [6]

$$
\left.
\begin{aligned}
&f1 = h_{2,0} + h_{0,2}\\
&f2 = (h_{2,0} + h_{0,2})^2 + 4h_{1,1}\\
&f3 = (h_{3,0} - 3h_{1,2})^2 + (3h_{2,1} - h_{0,3})^2\\
&f4 = (h_{3,0} + 3h_{1,2})^2 + (3h_{2,1} + h_{0,3})^2\\
&f5 = (h_{3,0} - 3h_{1,2})(h_{3,0} + 3h_{1,2})[(h_{3,0} + 3h_{1,2})^2\\
&- 3(h_{2,1} + h_{0,3})^2] + (3h_{2,1} - h_{0,3})(h_{2,1} + h_{0,3})\\
&[3(h_{3,0} + h_{1,2})^2 - (h_{2,1} + h_{0,3})^2]\\
&f6 = (h_{2,0} + h_{0,2})[(h_{3,0} + h_{1,2})^2 - (h_{2,1} - h_{0,3})^2]\\
&+ 4h_{1,1}(h_{3,0} + h_{1,2})(h_{2,1} - h_{0,3})\\
&f7 = (3h_{2,1} - h_{0,3})(h_{3,0} + h_{1,2})[(h_{3,0} + h_{1,2})^2\\
&- 3(h_{2,1} + h_{0,3})^2] + (3h_{1,2} - h_{3,0})(h_{2,1} + h_{0,3})\\
&[3(h_{3,0} + h_{1,2})^2 - (h_{2,1} - h_{0,3})^2]
\end{aligned}
\right\} \quad \text{... (6)}
$$

This set of normalized central moments is invariant to translation, rotation, and scale changes in an image.

5. The proposed technique for letter recognition

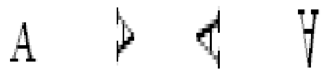
The technique used to recognize English letters

in an image. The proposed technique is applied to recognize English letters by converting that letter to the frequency domain depending on the use discrete cosine transform (DCT) as in Eq.1.After applying DCT, the technique uses the seven moments as mentioned as in Eq.6 to obtain the attributes for that letter. It can build a

database for each letter written in different directions with different font style.

Figuere1 shows the pictures of letter A can be written in different directions such as

a)



b)

Figure 1: pictures of letter A can be written in different directions

a) Font Arial Black type

b) Time New Roman type

The proposed technique applies the recognition to the letters written in two different fonts such as fonts Arial black and Time new roman with and different sizes such as 14, 12 and size 10.

The algorithm of the proposed technique is illustrated below:

Input :	**image contains characters**
Output :	**moment for each character with different direction**

***Step1*: enter image contains any character from English letters.**

***Step 2*: set the value of image to array C (k).**

***Step 3*: apply discrete cosine transform as mentioned in Eq. 1 to array C(k) and put the result into array CS(k).**

***Step 4*: 1)k=0**
2) for i=1 to width of image
3) for j=1 to height of image
4) Compute the seven moments as mentioned in Eq. 6 for the array CS (k).
K=k+1

5) next

6)next

***Step 5*:end**

6. Concluding Remark

The recognition of English capital letters depends on some measurements, in this research the proposed measurements can be used the seven moments for each letter.

The recognition technique deals with capital letters only.

From the test with different sizes and different fonts, it can see that each letter has range of moments for example, the first moment of letter A has the values greater than or equal to minus four and less than or equal to nine despite of it writes in different directions such as in figure 1 and so on.

It can give moments values range for any English capital letters with sizes from 14 to 10 as show in table 3 because more printed documents can be written in this sizes.

7. References

1- J.P. Marques de sa'**,"** **Pattern Recognition Concepts, Methods And Applications",** copyright -, 2001, Elsevier, USA**.**

2-T.SERGIO**,"** **pattern recognition**", second edition, department of informatics and telecommunications, university of Athens, Greece, 2001, Elsevier, USA .

3-K.Konstantionos," **pattern Recognition**", second edition, Institute of space applications & Remote sensing, National Observatory of Athens, 2003 .

4- J.Stephen and R. Yogesh", **Modeling Facial Colour and Identity with Gaussian Mixtures**", 2000 .

5- T.Acharya and A.K. Ray," **Image Processing Principles And Applications**", TA1637, A3, 2005.

6- S.Ghosal ,"**A Moment Based Identified Approach To Image Feature Detection**", IEEE transactions on image processing,2000.

Example (1):-

Suppose it has the characters A and B can be written in English capital letter in different directions, same fonts and sizes.

Such as

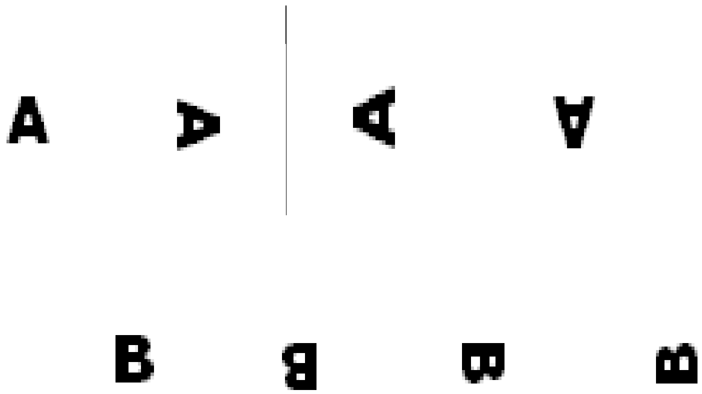


Figure 2: images of the letters A and B can be written in English capital letter in different directions.

From the test to the images shown in figure 2 and after computing the seven moments for these characters it obtains the same values for all moment values if they write in different directions but same fonts and sizes it has different values for each moment if it can written in different sizes and different fonts these values are illustrated in table 1 and table2.

Table 1 shows the seven moments for characters A and B write in *Font Arial Black*

	Fonts Arial Black and size =14		***Fonts Arial Black and size =12***		***Fonts Arial Black and size =10***	
	Letter A	**Letter B**	**Letter A**	**Letter B**	**Letter A**	**Letter B**
1 Moment	**-2.98**	**-3.87**	**8.58**	**-4.28**	**2.11**	**3.61**
Moment 2	**8.92**	**1.5**	**7.36**	**1.83**	**4.49**	**1.30**
Moment 3	**7 .08**	**8.30**	**2.51**	**2.04**	**1.18**	**2.57**
Moment 4	**7.08**	**8.30**	**2.51**	**2.04**	**1.18**	**2.57**
Moment 5	**-5.95**	**-7.5**	**-3.99**	**-9.27**	**-4.08**	**-1.30**
Moment 6	**7.48**	**1.34**	**1.17**	**8.57**	**1.58**	**6.55**
Moment 7	**3.16**	**4.74**	**-3.26**	**1.36**	**-3.86**	**-1.38**

Table 2 shows the seven moments for characters A and B write in *Font Time New Roman*

	Fonts Time New Roman and size =14		***Fonts Time New Roman and size =12***		***Fonts Time New Roman and size =10***	
	Letter A	**Letter B**	**Letter A**	**Letter B**	**Letter A**	**Letter B**
1 Moment	**6.84**	**8.70**	**1.66**	**2.94**	**1.34**	**1.67**
Moment 2	**4.685**	**7.58**	**2.76**	**8.69**	**1.79**	**2.79**
Moment 3	**1.05**	**1.47**	**1.52**	**7.03**	**1.79**	**1.53**
Moment 4	**1.05**	**1.47**	**1.52**	**7.03**	**1.79**	**1.53**
Moment 5	**-1.08**	**-5.67**	**-5.94**	**-1.86**	**-7.58**	**-6.02**
Moment 6	**4.92**	**2.85**	**1.08**	**2.34**	**7.63**	**1.09**
Moment 7	**-1.10**	**-1.89**	**-3.80**	**-3.16**	**-3.61**	**-3.86**

Example (2):-

Suppose you enter the text "PATTERN", in size =13 the seven moments for each letter of the text is show in the table3.

Table 3 shows the seven moments for the word "PATTERN",

	Letter P	Letter A	Letter T	Letter E	Letter R	Letter N
Moment 1	1	8	1	-4	2	2
Moment 2	2	3	3	1	8	8
Moment 3	1	2	3	6	7	6
Moment 4	1	2	3	6	7	6
Moment 5	-6	-3	-2	-4	-1	-1
Moment 6	1	1	1	1	2	2
Moment 7	-3	-3	-9	4	-3	-3

If the test apply to all English capital letters can be written in different fonts and sizes limited between 10, 12 and 14 , it can find that each letter has moment range approximately between two values for any letter can be written in different shapes, the moments must obtain between these values the test illustrated in table 4 .

	Moment 1	Moment 2	Moment3	Moment4	Moment5	Moment 6	Moment 7
A	-4=A= 9	2 =A = 9	1 =A = 7	1 =A = 7	-7 = A =-1	1= A = 8	-4= A = 3
B	-4=B= 9	1 =B = 9	1 =B = 9	1 = B = 9	-9 =B = -1	1 =B = 9	-3 =B= 5
C	-8=C= 4	1 = C = 7	1 = C = 4	1 = C = 4	-5 = C= -2	1 = C = 4	-8 =C = 2
D	-9=D= 3	2 =D = 9	1 =D = 7	1 = D = 7	-5 =D = -1	0 =D = 4	-2=D = 7
E	-5=E= 9	1=E = 10	1 = E= 7	1 = E = 7	-5 = E= -1	1 = E = 4	-3= E = 6
F	-8=F= 3	0 = F = 8	1= F = 6	1= F = 6	5 =F = -1	0 = F = 8	-3= F = 5
G	0 =G= 2	0= G = 3	1 = G = 4	1 = G = 4	-9 =G= -1	1 = G = 6	-3 =G = 0
H	-4=H= 7	0 =H = 5	1 =H = 7	1 = H = 7	-8 = H =-4	1 =H = 5	-8=H = 3
I	-8= I = 7	1 = I = 10	1 = I = 7	1 = I = 7	-4 = I =-1	1 = I = 9	-5 = I = 3
J	-4= J= 4	1= J = 10	1 = J = 6	1 = J = 6	-9 = J =-1	1 = J = 9	-7 = J = 3
K	-6= K= 9	2 = K = 9	1 = K = 6	1 = K = 6	-5 = K -1	1= K = 9	-4 =K= 6
L	-7=L= 8	1 = L = 7	1 =L= 1 0	1 = L=1 0	-9 = L =-1	1 =L = 7	-9= L = 5
M	-1=M= 6	0 =M = 6	1 =M = 6	1= M = 6	-5 =M =-1	0= M = 6	-9 =M= 2
N	-8=N= 9	2 =N= 9	1 = N = 8	1 = N = 8	-7 = N =-1	1 =N = 8	-3=N = 1
O	-3=O= 8	2=O = 10	1 =O = 3	1 = O= 3	-6 =O= -1	1 =O = 9	-4=O = 6
P	-4=P= 9	1 =P =8	1 = P= 3	1= P = 3	-6 =P = -1	1 = P = 3	-4 =P= 2
Q	-9=Q= 3	2 =Q= 10	1 = Q = 8	1 = Q= 8	-5= Q= -2	1 =Q = 8	-2 =Q= 8
R	-7 =R= 9	1=R= 1 0	2 = R = 7	2 = R = 7	-4 =R = -1	1 = R= 3	-3= R= 5
S	-9 = S=9	0 =S = 8	1 = S = 3	1 = S =3	-7 =S = -1	0 = S = 8	-4=S = 4
T	-8=T= 5	1 = T = 9	1 = T = 8	1= T =8	-7 = T =-2	1 = T = 9	-9 =T = 4
U	-5 =U= 7	1 = U= 6	1 = U = 6	1 = U = 6	-4 =U= -1	1 = U= 9	-3=U= 10
V	-6 =V= 4	1 = V = 9	1 = V = 8	1 = V = 8	-7 = V= -1	1 = V = 9	-4 =V= 6
W	-6=W= 1	0 =W = 4	1 = W = 8	1= W = 8	-7=W = -1	0 = W= 9	-6=W= 8
X	-7=X= 4	2 =X = 10	1 = X = 9	1 = X = 9	-8 = X =-1	1 = X = 8	-8= X= 9
Y	-7=Y= 4	0 =Y = 10	1 = Y = 5	1 = Y = 5	-10=Y= -1	0 = Y = 6	-9 =Y = 6
Z	-6=Z= 9	1 = Z = 9	1 = Z = 9	1 =Z = 9	-8 = Z =-1	1 = Z = 9	-9 = Z = 6

Table- 4 -shows the seven moments range for any English capital letter can be written in sizes 10, 12 and size=14 in different sizes and directions.

Figures below show the moments frequencies for characters A and B show in figure 2 and computed in table1 and table2

a) Font Arial black and size=14

b) Font Time New Roman and size=14

c) Font Arial black and size=12

d) Font Time New Roman and size=12

e) Font Arial black and size=10

f) Font Time New Roman and size=10

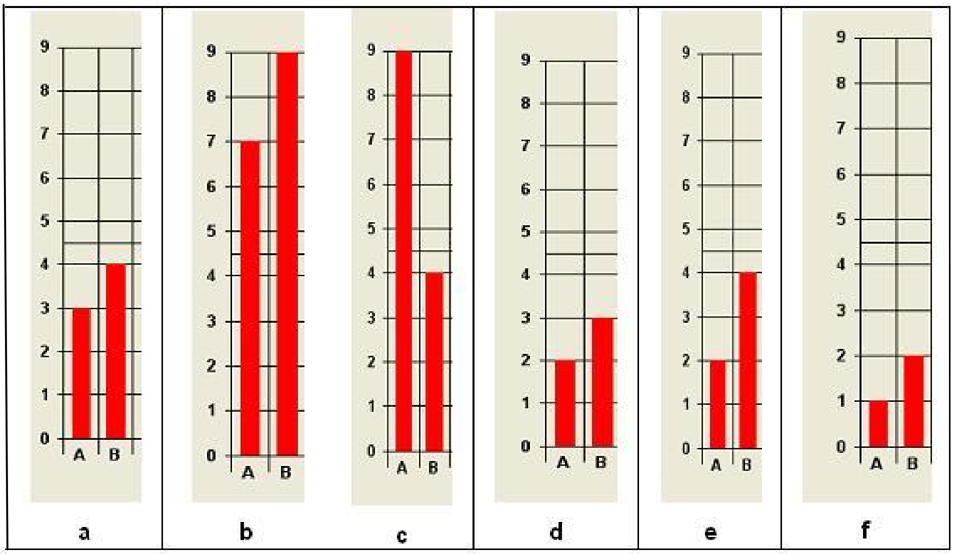


Figure3: the first moment for character A and B

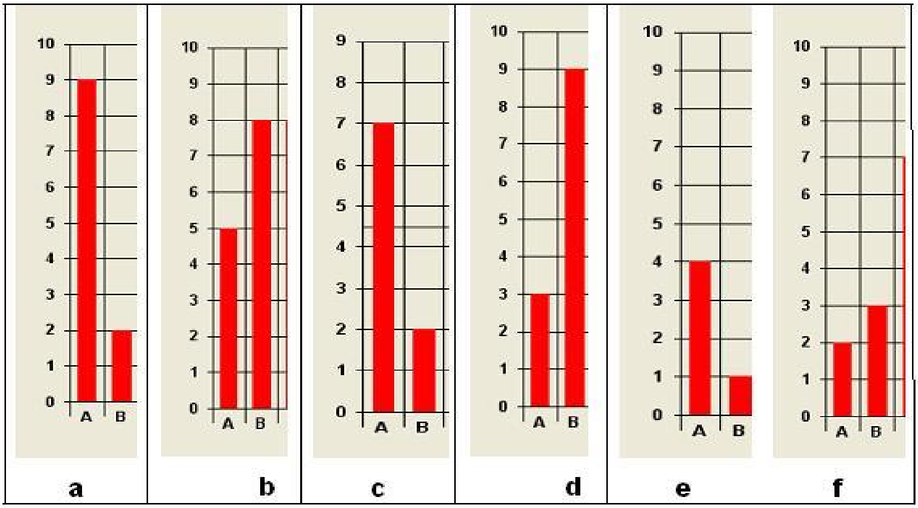


Figure4: the second moment for character A and B

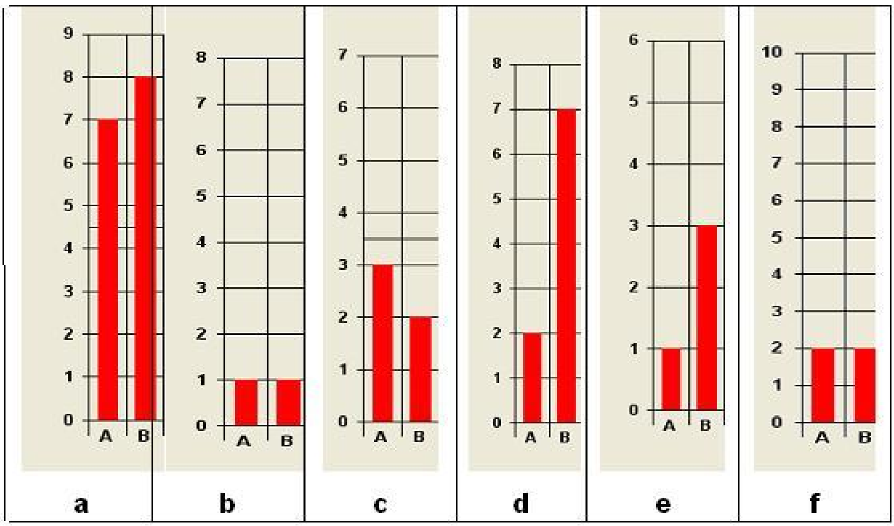


Figure5: the third moment for character A and B

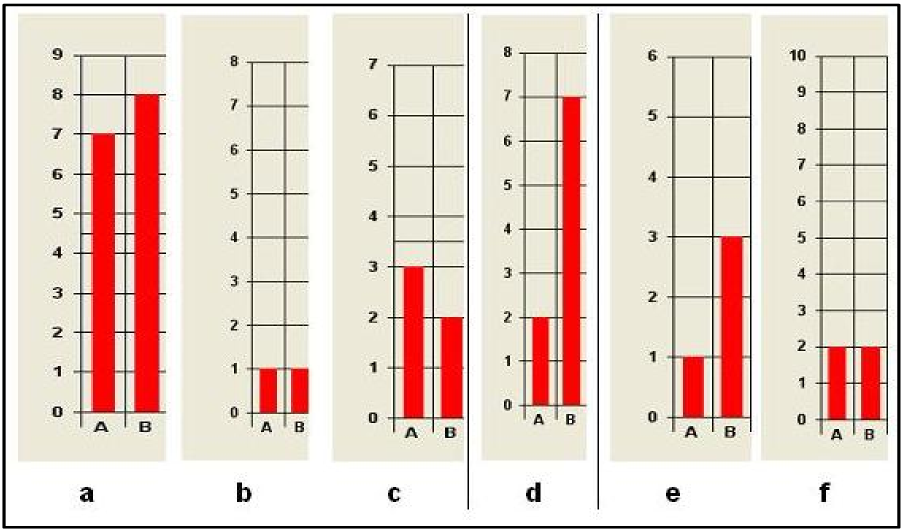


Figure6: the forth moment for character A and B

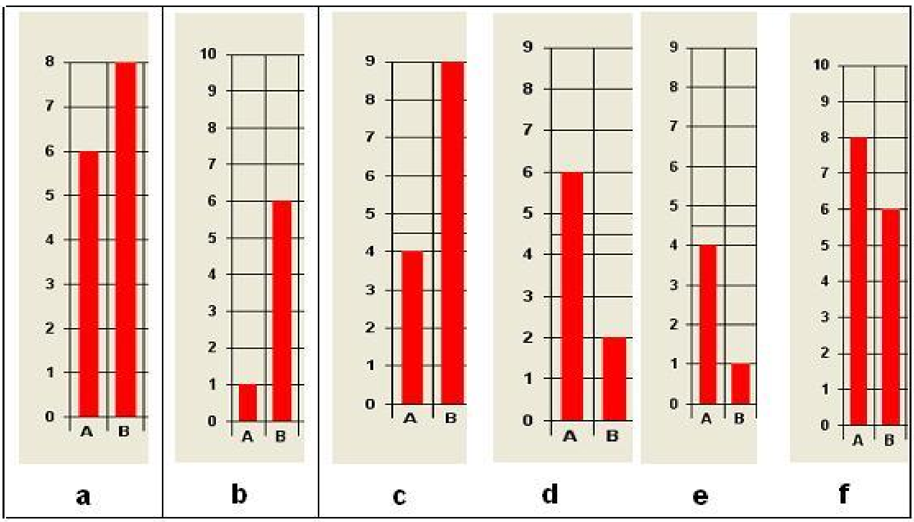


Figure7: the fifth moment for character A and B

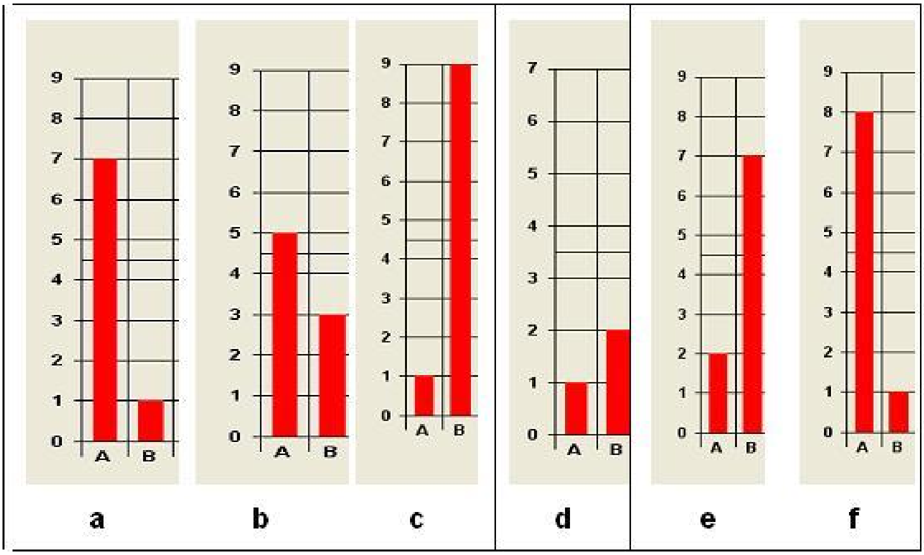


Figure8: the sixth moment for character A and B :

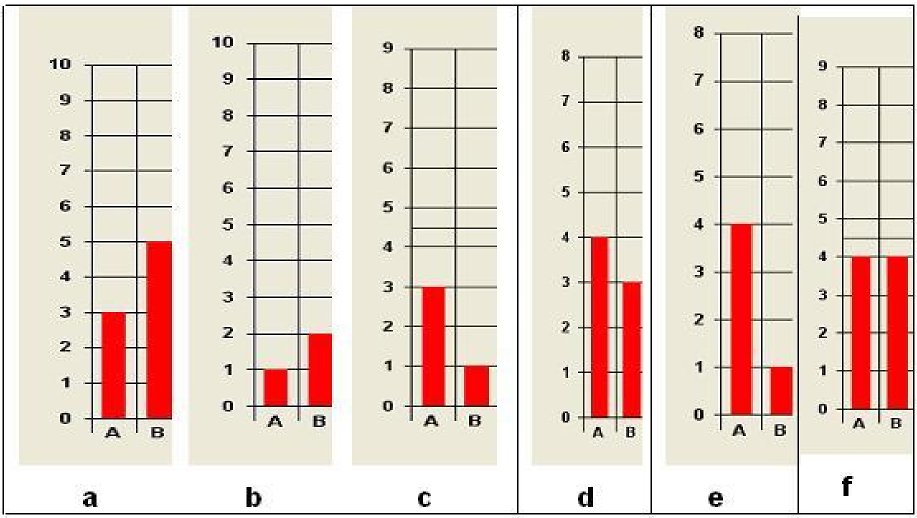


Figure9: the seventh moment for character A and B :

تمييز الأحرف الأنكليزية الكبيرة بالأعتماد على حساب العزوم السبعة

أ.د. عبدالمنعم ابو طبيخ * م.م.اخلاص ناصر*

المستخلص

هنالك الكثير من الصور الرقمية للوثائق المطبوعة والبحث مازال مستمراً للوصول الى افضل الخوارزميات في التعرف على رموز الأحرف الأنكليزية التي هي اكثر شيوعاً وقد كان هنالك مساحة كبيرة لها في هذة البحوث. يستخدم هذا البحث صورة تحوي حرفاً واحداً وطريقة التمييز المقترحة تبدأ بتحويل الصورة الى frequency domain وذلك بتطبيق قانون التحويل(DCT) بعدها تحسب العزوم السبعه لذلك الحرف لأبراز مزايا الحرف ثم بناء قاعدة بيانات تعتمد على هذه المزايا لعملية التمييز.الهدف من البحث هو برهنة كل حرف كبير كتب بنفس الخط والحجم لكن بأتجاهات مختلفه هو واحد من الحروف الأنكليزية الكبيرة أيضا وذلك لأمتلاكة نفس قيم العزوم السبعةً.

* قسم علوم الحاسوب/ الجامعة التكنولوجية