University of Thi-Qar Journal Vol. 13 No.4 DEC 2018
Web Site: https://jutq.utq.edu.iq/index.php/main
Email: journal@jutq.utq.edu.iq

Gestures conversion to Arabic letters

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Abstract:

Gestures is one of the best ways of communication between dumb and blind people depend on the expression of signs. In this paper we suggest an algorithm to recognizing hand gestures of Arabic latters to communicate between the dumb (through signs) and blind (hear the voice corresponding to sings).The proposed algorithm used the video of gesture from the dumb then convert the video into frames (images) and calculate the distance to recognition the letters by using k-mean , k-medoid and artificial neural network, calculate the distance by using Euclidean distance and slop .There are sixteen features (8-features from Euclidean distance and 8-features from slop). The results were (93.3% For k-mean),(93.1% for k-medoid) and(92.9% for ANN).We create our data base (from 5- videos with 308 frames).

Keywords*:* gestures, Feature Extraction, k-mean cluster ,k-medoid cluster ,artificial neural network.

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تحويل الإيماءات إلى الحروف العربية

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الملخص:
الإيماءات هي واحدة من أفضل الطرق للتواصل بين البكم والأشخاص المكفوفين تكون عن طريق استخدام الاشارة (للابكم) والسمع (للمكفوف) للتواصل بينهم. في هذه البحث تم اقتراح خوارزمية للتعرف على لغة عن طريق الاشارة اليد للحروف العربية لكي يتواصل بين البكم (من خلال الاشارات) والمكفوفين (سماع صوت التي تمثل الاشارة). استخدمت الخوارزمية المقترحة فيديو للبكم والذي يمثل الاشارات ثم تحويل الفيديو إلى الصور ومن خلال حساب المسافة الاقليدية والميل يتم التعرف على الحروف باستخدام k-mean ، k- medoid والشبكة العصبية الاصطناعية . هناك ستة عشر ميزة (8 ميزات من المسافة الإقليدية و 8- ميزات من الميل). كانت النتائج (93.3 ٪ بالنسبة إلى k-mean) و (93.1 ٪ لـ k-medoid) و (92.9 ٪ لـ ANN) .يم استخدام قاعدة بيانات (من خمسة مقاطع فيديو مع 308 صورة).

الكلمات المفتاحية: الإيماءات ، استخلاص الخواص ، k-mean ، k-medoid ، الشبكة العصبية الاصطناعية.

1. Introduction

Communication is the way for expression about thoughts, opinions, information, or messages between the people by writing, speaking, or signs. Communication is usually oral expression between people by talking to each other while people dumb cannot communicate with others as ordinary people do, they cannot speaking people who are deaf are able to speak, but they unable to hear. While the blind are unable to see but they can speaking and listen [1].

Gesture is a kind of nonverbal communication with a part of body, which used together with verbal communication. The gestures are obscure not totally specific. Like the talk and handwriting, gestures change from individual to individual, even to the same person in different cases[2].

Gesture is the language used by dumb and blind people. Dumb people use signs to show their ideas. Signal language is different from each country to another country with its special vocabulary and grammarian. In fact, sign language can vary in one country from one place to another, as Languages spoken [3]. Gesture is the movement of any part of the body such as the face and hands a kind of motion[4].

There are two methods for recognize the gesture; first way is based glove and the second way based on computer. The first way depends on the hardware, and gets information from the joints of the hand by using sensors to know the classification of hand gesture. This way use video and convert the video into frames to identify the pattern the know the hand gestures [5].

Recognize of sign language at present, by taken gesture of humans using video camera such as a mobile , tablet, or laptop computer [6] then convert the video into image and extract the features then classify each letters into voice to make the blind hear the letters .This paper focuses on the how the sign language translate into voice to make the dumb and blind communicate.As show figure 1.

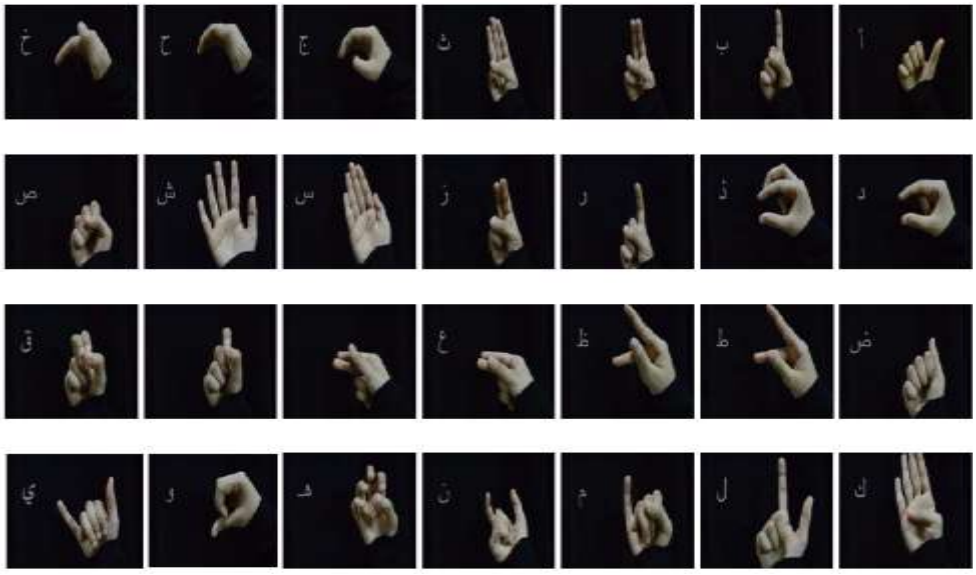

Figure1.Signs of Alphabets

2. Clustering Algorithms

There are many types of clustering algorithms , we use the K-mean, K-mediod algorithms, and we found that K-mean is the best one when the

database less than 500 images.

2.1.K-Mean Cluster

K-Mean clustering algorithm uses the mean/centroid to represent the cluster. It divides the database comprising of m data items into k clusters in such a manner that each one of the m database elements belongs to a cluster with nearest possible mean/centroid [7].

K-Means Algorithm:

1.Determine the number of clusters K, which is a preliminary initialization step in this work ,the number of K=28.

2.choose initial center.

3.Calculate the Euclidean distance square between the points (16 points) with the centers(28 centers for each group of letters) , there are 8 points from Euclidean Distance , and 8 points from Slop. As show in equation (1)[8].

$$\sum_{i=1}^{n}(x_{zi} - x_{oi})^2 = \mathrm{DE}_{zo} \quad \ldots\ldots(1)$$

Where as:

n: Number of example properties.

x_{zi}::The coordinates of the i property for example z

x_{oi}:The coordinates of the i property for example o (usually the coordinates of the center).

4. collect the data with the nearest center.

5.Repeat steps 2 to 4 until stability (there are no objects moving within clusters), or even repetition a certain number of times.

2.2.K-Medoid Cluster

The K-Medoids cluster is one of the non-automatic bunch algorithm. Rather than using Traditional Central, medoid can be used to explain cluster. A medoid is a statistical method, which represents the data organ in the data set is reducing the average difference for other members of the bunch. Thus, the anesthetic, unlike the medium, always a part of the data set. It represents more than others centralized data subject in your data set. The work of the K-medoid algorithm is analogous to the K-means aggregation algorithm. Additionally, it starts with at random selected k data [9].

K- Medoid Algorithm:

Input:
k: number of clusters
D: the data set that contains n elements.
Output:
A set of K cluster that reduce the sum of the differences of all objects to their nearest medoids .As show in equation(2) [9].

$$Y=\sum_{i-1}^{k}\sum \left| z-m_i \right| \qquad (2)$$

Y: Sum of absolute error for all items in the data set
z: the data point in the space representing a data item
m_i: is the medoid of cluster C_i
Steps:

1. choose initial medoid.
2. Set each remaining data element to a cluster with the closest medoid.
3. Randomly select the non-medoid data component and calculate the total cost to swap the medoid data item with the currently selected non-medoid data item.
4. If the total cost of the swap is less than zero, perform the swap process to create a new set of k-midoids.
5. Repeat steps 2, 3 and 4 till the medoids stabilize their locations.

2.3. Artificial Neural Network

Artificial neural networks are one of the techniques it solved a variety of problems at a fairly easy and comfortable way[3]. We Use the

neural network model to identify the hand gesture in the image as in the K-mean and K-medoid.

We use feed forward neural network to training the gesture images and find the specific cluster for each letters as in the K-mean algorithm.

ANN Algorithm:

1. input and target for ANN (16-input).
2. Use 28 hidden layer.
3. Training the ANN to set the weight.
4. Calculate the 5 output (numbers of letter)

3.Proposed Algorithm

The proposed algorithm consist of four steps as show in figure 2.

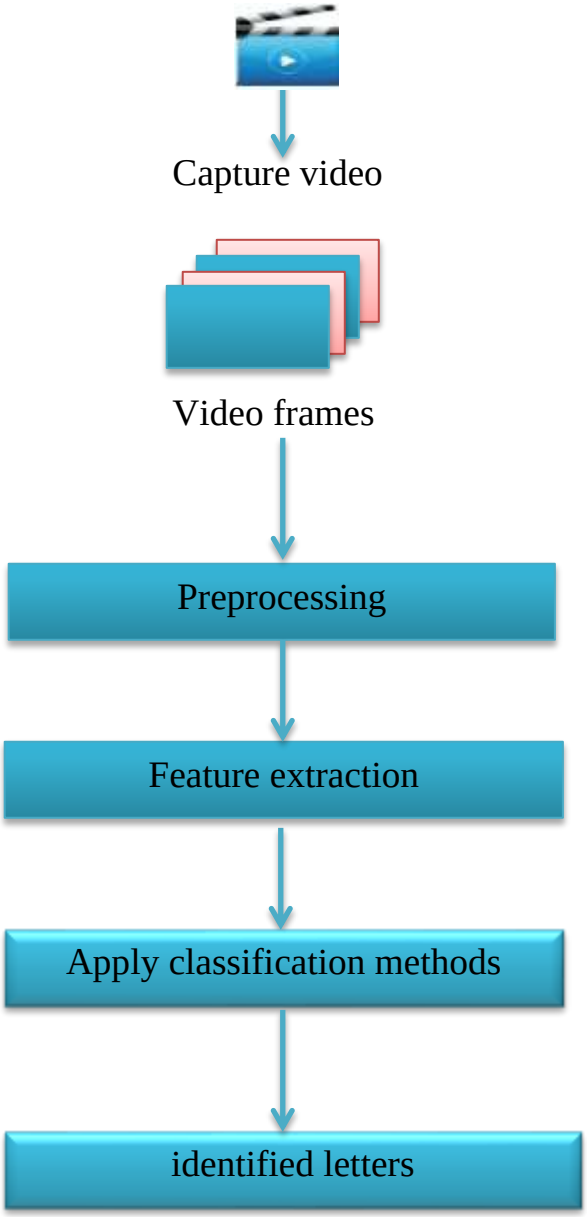

Figure2.General Block Diagram of Sign Language Recognition System

Step.1. Dataset Acquisition

We created the data set by using an external camera in our laboratory. Here we used different cameras to create the data set. The background must be black color to create a data set of gestures letters. where we focus on hand only. The position of camera is most important issues, because removing the background will rise such problems of removing background , as background noise.
Here we took 28 characters in Arabic (ا,ب,ت....ي) letters from three different people, where the characters recorded as different templates for each times. Part of the videos is divided into a series of frames (images) of size 720 * 1280 and the other parts into a series of frames with size 720 * 1280.
In this paper we used (for training stages) five videos contains 37 frames (images) with 1280 * 720 and 308 frames (images) with size (1280*720 and 720*1280) .

Step2 .Pre-Processing

The Pre-processing include the following steps:

1. Transform the videos into the required frames (Image $_K$)
2. Convert the image(Image $_K$) to gray scale format.
3. Convert 8-bit image (Image $_K$) into double image.
4. Transform the gray scale image (Image $_K$) to a binary image.
5. Segment hand area.
6. Create mask for hand area.
7. Remove little objects from the binary image using morphological operations (Erosion) by multiplying each image with a hand-sized mask.
8. Using sobel operator to find the edge of image to detect the area of hands.
9. Resize the image [any * 100].

Step3.Feature Extraction

In our proposed algorithm there are 16-geometrics features for each frame (image) these 16 features divided into two sets; the first set is consist of (8-features) from calculate the distance between the 8 points with the center of hand as shown in Figure.3 and the second set also include (8-features) from calculate the slop of these 8 points in first set

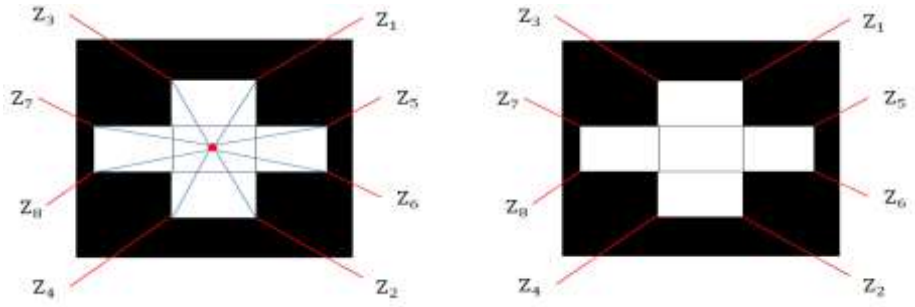

Figure 3. a)distance between center and points b)points

We can calculate the 16-features by using as following equations:

1.calclating the 8-features include the distance of 8 points by using Euclidean distance from the center of palm to the 8- points by using the equations (3)[10] and equation (4)[8]:

$$points = \{Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8\} \dots\dots\dots\dots\dots\dots (3)$$

$$DE_{zo} = \sqrt{\sum_{i=1}^{n} (x_{zi} - x_{oi})^2} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

Where as:

(

n: number of properties

DE_{zo}: distance between points and center of palm

x_{zi} : The coordinates of the i property for Z (where Z: points)

x_{oi}: The coordinates of the i property for o (where o:center point of palm)

2.The second 8-features include the slop from center of palm to the 8-points as show in equation (5)[11].

$$Slop = \frac{yz - yo}{xz - xo} \dots\dots\dots\dots\dots\dots\dots\dots\dots (6)$$

Where as:

yz: the y- axis value when points

x_z: the x- axis value when points

y_o: the y- axis value when center point of palm

x_o: the x- axis value when center point of palm

3.calculate center point of palm as in equation (7)[12].

$$x_o = \frac{\sum xoiAi}{\sum Ai}, \qquad y_o = \frac{\sum yoiAi}{\sum Ai} \dots\dots\dots\dots\dots\dots\dots (7)$$

Where:

x_o: the x- axis value when center point of palm

y_o: the y- axis value when center point of palm

x_{oi}: The distance at which the center of the shape moves away from the junction point of the axes on the axis (x)

y_{oi}: The distance at which the center of the shape moves away from the junction point of the axes on the axis (y)

A_i: area the shape

4. Calculate the feature vector for each letter (28 letters) by using two ways:

a. by calculate the average of features for the same letters from different images of the same letter.

b. by calculate the feature vector for the first image of the letter and ignore the rest images of the same letter.

4. Result

By using our proposed algorithm , we first calculate the features 16-features for each image as shown in (Table 1 and 2) for distance and slop respectively, then calculate the features for each letters 28- letters as show in (Table 3and 4) for the average (first) way which mentioned in (features extraction step) and(Table 5 and 6) for the second way in (features extraction step). when we used five videos with 345 frames (images) we found that the results from three clustering algorithms; K-mean , K-mediod and ANN, for 28 letters which gave different results for recognition as following:

1. K-Mean Algorithm

When we Implement of the k-mean cluster algorithm on the extracted features we found the accuracy of this algorithm is(99.0347%) for training stage when the dataset is 37 and (93.3673%) for training stage when the dataset is 308, as shown in Table 9.and 10 respectively.

2.k-medoid cluster

When we Implement of the k-medoid cluster algorithm on the extracted features we found the accuracy of this algorithm is(98.0695%) for training stage when the dataset is 37 and 93.1354%) for training stage when the dataset is 308, as shown in Table 9.and 10 respectively.

3.Artifical neural network

When we Implement of the ANN algorithm on the extracted features we found the accuracy of this algorithm is(93.8224%) for training stage when the dataset is 37 and (92.9499%) for training stage when the dataset is 308, as shown in Table 9.and 10 respectively.

Table. 1 Euclidian Distance (from database1) of training stage

No	Dst1	Dst2	Dst3	Dst4	Dst5	Dst6	Dst7	Dst8

1	276.9986	288.1363	294.1965	291.1387	206.0604	208.3231	203.4375	201.4196
2	355.4818	355.5265	194.9336	197.7438	235.0292	236.6008	185.1513	172.2230
3	293.6953	293.9013	212.3455	214.7117	244.0237	244.2586	160.9060	158.1854
4	311.6084	311.3452	222.4451	224.7855	249.8898	250.5631	170.6447	159.6437
5	296.2723	292.6975	238.3328	240.8885	262.4241	263.2645	240.5078	246.4137
6	169.8624	173.0793	244.4411	244.5451	205.3576	201.216	285.2882	284.8284
7	157.2887	153.3942	246.3978	248.2616	213.3613	209.0347	301.5246	300.3455
8	199.8922	196.3587	243.6148	244.6593	210.2917	207.7755	327.8446	326.8174
9	200.2367	196.5553	248.6742	250.0439	210.0441	206.8274	333.5782	332.1838
10	180.2222	175.5220	258.7946	259.6579	202.4161	197.9950	312.4436	312.8322

No	Dst1	Dst2	Dst3	Dst4	Dst5	Dst6	Dst7	Dst8
1	276.9986	288.1363	294.1965	291.1387	206.0604	208.3231	203.4375	201.4196
2	355.4818	355.5265	194.9336	197.7438	235.0292	236.6008	185.1513	172.2230
3	293.6953	293.9013	212.3455	214.7117	244.0237	244.2586	160.9060	158.1854
4	311.6084	311.3452	222.4451	224.7855	249.8898	250.5631	170.6447	159.6437
5	296.2723	292.6975	238.3328	240.8885	262.4241	263.2645	240.5078	246.4137
6	169.8624	173.0793	244.4411	244.5451	205.3576	201.216	285.2882	284.8284
7	157.2887	153.3942	246.3978	248.2616	213.3613	209.0347	301.5246	300.3455
8	199.8922	196.3587	243.6148	244.6593	210.2917	207.7755	327.8446	326.8174
9	200.2367	196.5553	248.6742	250.0439	210.0441	206.8274	333.5782	332.1838
10	180.2222	175.5220	258.7946	259.6579	202.4161	197.9950	312.4436	312.8322

Table. 2 Slop (from database1) of training stage

No	S1	S2	S3	S4	S5	S6	S7	S8
1	-1.2725	-1.3543	-1.6549	-1.7228	-0.6743	-0.6977	-4.3231	-5.5290
2	-0.0433	-0.0461	1.5056	1.4389	-0.3199	-0.3423	-1.5181	-2.0385
3	0.0063	-0.038	1.3849	1.3417	-0.2395	-0.2438	-1.4986	-1.5875
4	0.0536	0.0343	1.4075	1.3651	-0.2242	-0.2365	-1.3652	-1.7030
5	0.2717	0.2192	1.2199	1.1884	-0.1609	-0.1802	0.6472	0.6255
6	-0.3091	-0.3707	20.8458	17.8054	0.3993	0.3364	-9.8855	-11.9699
7	0.5870	0.5280	3.8230	3.4371	0.5063	0.4538	-6.1552	-7.3754
8	0.3400	0.2766	3.8166	3.5844	0.4778	0.4462	-4.593	-4.9477
9	0.2924	0.2143	3.6440	3.3867	0.4602	0.4183	-4.6726	-5.1934
10	0.3378	0.2382	6.0421	5.4028	0.3294	0.2461	5.1333	4.9670

Table. 3 Euclidian Distance (from database1) of training stage

No	No of image	Letter	Dst1	Dst2	Dst3	Dst4
1	1	أ	276.9986	288.1363	294.1965	291.1387
2	1	ب	355.4818	355.5265	194.9336	197.7438
3	2	ت	302.6518	302.6232	217.3953	219.7486
4	1	ث	296.2723	292.6975	238.3328	240.8885
5	1	ج	169.8624	173.0793	244.4411	244.5451
6	1	ح	157.2887	153.3942	246.3978	248.2616
7	2	خ	200.0645	196.4570	246.1445	247.3516
8	1	د	180.2222	175.5220	258.7946	259.6579
9	1	ذ	244.71765	242.3075	276.6714	280.0436
10	1	ر	344.7340	345.3152	204.8516	205.3970

No	No of image	Letter	Dst5	Dst6	Dst7	Dst8
1	1	أ	206.0604	208.3231	203.4375	201.4196
2	1	ب	235.0292	236.6008	185.1513	172.223
3	2	ت	246.9568	247.4109	165.7753	158.9145
4	1	ث	262.4241	263.2645	240.5078	246.4137
5	1	ج	205.3576	201.2160	285.2882	284.8284
6	1	ح	213.3613	209.0347	301.5246	300.3455
7	2	خ	210.1679	207.3015	330.7114	329.5006
8	1	د	202.4161	197.9950	312.4436	312.8322
9	1	ذ	233.8887	231.3922	292.2444	292.6517
10	1	ر	204.4025	234.5506	193.6203	185.4788

Table. 4 Slop (From Database1) of Training Stage

No	No of image	Letter	S1	S2	S3	S4
1	1	أ	-1.2725	-1.3543	-1.6549	-1.7228
2	1	ب	-0.0433	-0.0461	1.5056	1.4389
3	2	ت	0.0299	-0.0016	1.3962	1.3534
4	1	ث	0.2717	0.2192	1.2199	1.1884
5	1	ج	-0.309	-0.3707	20.8458	17.8054
6	1	ح	0.5870	0.5280	3.8230	3.4371
7	2	خ	0.3162	0.2454	3.7303	3.4856
8	1	د	0.3378	0.2382	6.0421	5.4028
9	1	ذ	0.2040	0.1456	3.6980	3.1711
10	1	ر	-0.0259	-0.0636	1.5436	1.5298

No	No of image	Letter	S5	S6	S7	S8
1	1	أ	-0.6743	-0.6977	-4.3231	-5.5290
2	1	ب	-0.3199	-0.3423	-1.5181	-2.0385
3	2	ت	-0.2319	-0.2401	-1.4319	-1.6452
4	1	ث	-0.1609	-0.1802	0.6472	0.6255
5	1	ج	0.3993	0.3364	-9.8855	-11.9699
6	1	ح	0.5063	0.4538	-6.1552	-7.3754
7	2	خ	0.4690	0.4322	-4.6328	-5.0705
8	1	د	0.3294	0.2461	5.1333	4.9670
9	1	ذ	0.2801	0.2357	10.4731	9.1548
10	1	ر	0.0143	-0.5630	-1.4411	-1.6678

Table. 5 Euclidian distance (from database1) of training stage

No	No of image	Letter	Dst1	Dst2	Dst3	Dst4
1	1	أ	276.9986	288.1363	294.1965	291.1387
2	1	ب	355.4818	355.5265	194.9336	197.7438
3	2	ت	293.6953	293.9013	212.3455	214.7117
4	1	ث	296.2723	292.6975	238.3328	240.8885
5	1	ج	169.8624	173.0793	244.4411	244.5451
6	1	ح	157.2887	153.3942	246.3978	248.2616
7	2	خ	199.8922	196.3587	243.6148	244.6593
8	1	د	180.2222	175.5220	258.7946	259.6579
9	1	ذ	244.7177	242.3075	276.6714	280.0436
10	1	ر	344.7340	345.3152	204.8516	205.3970

No	No of image	Letter	Dst5	Dst6	Dst7	Dst8
1	1	أ	206.0604	208.3231	203.4375	201.4196
2	1	ب	235.0292	236.6008	185.1513	172.2230
3	2	ت	244.0237	244.2586	160.9060	158.1854
4	1	ث	262.4241	263.2645	240.5078	246.4137
5	1	ج	205.3576	201.216	285.2882	284.8284
6	1	ح	213.3613	209.0347	301.5246	300.3455
7	2	خ	210.2917	207.7755	327.8446	326.8174
8	1	د	202.4161	197.9950	312.4436	312.8322
9	1	ذ	233.8887	231.3922	292.2444	292.6517
10	1	ر	204.4025	234.5506	193.6203	185.4788

Table. 6 slop (from database1) of training stage

No	No of image	Letter	S1	S2	S3	S4
1	1	أ	-1.2725	-1.3543	-1.6549	-1.7228
2	1	ب	-0.0433	-0.0461	1.5056	1.4389
3	2	ت	0.0063	-0.0380	1.3849	1.3417
4	1	ث	0.2717	0.2192	1.2199	1.1884
5	1	ج	-0.3090	-0.3707	20.8458	17.8054
6	1	ح	0.5870	0.5280	3.8230	3.4371
7	2	خ	0.3400	0.2766	3.8166	3.5844
8	1	د	0.3378	0.2382	6.0421	5.4028
9	1	ذ	0.2040	0.1456	3.6980	3.1711
10	1	ر	-0.0259	-0.0636	1.5436	1.5298

No	No of image	Letter	S5	S6	S6	S8
1	1	أ	-0.6743	-0.6977	-4.3231	-5.5290
2	1	ب	-0.3199	-0.3423	-1.5181	-2.0385
3	2	ت	-0.2395	-0.2438	-1.4986	-1.5875
4	1	ث	-0.1609	-0.1802	0.6472	0.6255
5	1	ج	0.3993	0.3364	-9.8855	-11.9699
6	1	ح	0.5063	0.4538	-6.1552	-7.3754
7	2	خ	0.4778	0.4462	-4.5930	-4.9477
8	1	د	0.3294	0.2461	5.1333	4.9670
9	1	ذ	0.2801	0.2357	10.4731	9.1548
10	1	ر	0.0143	-0.5630	-1.4411	-1.6678

Table 7.Result Classify (From Database1) of Training Stage

No	k-mean	k-medoid	ANN
1	1	1	5
2	2	10	20
3	3	11	17

4	3	11	15
5	4	4	19
6	5	9	20
7	6	6	20
8	7	7	20
9	7	7	19
10	8	8	15

Table 8.Result Classify (From Database2) of Training Stage

No	k-mean	k-medoid	ANN
1	1	5	24
2	11	19	19
3	7	17	19
4	7	17	20
5	7	17	21
6	8	22	14
7	7	17	17
8	7	17	16
9	26	10	17
10	26	10	17

Table.9 The Algorithms Efficiency for the Database1

No-Of Image	Efficiency Of k-means	Efficiency Of k-medoid	Efficiency Of ANN
37	99.0347%	98.0695%	93.8224%

Table.10 The Algorithms Efficiency for the Database2

No-Of Image	Efficiency Of k-means	Efficiency Of k-medoid	Efficiency Of ANN
308	93.3%	93.1%	92.9%

5. Conclusion

In this paper, we have designed a system for recognition Arabic alphabets in sign language based on clustering methods. Our proposed algorithm we found that the two way of calculating the features in average way and took the first letter way for the features , that the average way gives good results with K-mean only and give bad results with other clustering algorithms (K- mediod and ANN) .

while the second way (calculate the feature vector for the first image of the letter and ignore the rest images of the same letter) gives good results with (K- medoid) while it gives bad results with (K- mean and ANN).

In the ANN we use the algorithm in section (2.3) which give as the lowers results. The best result we obtained from K-mean, then K-mediod, and the last one from ANN.

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