# Automatic Verification for Handwritten Based on Gray Level Co-occurrence Matrix (GLCM) Properties and Seven Moments

[1]Bara'a Wasfi Salim, [2]Saman M. Almufty, [3]Renas Rajab Asaad

[1]ITM Dept., Technical College of Administration, Duhok Polytechnic University, Kurdistan Region – Iraq

[2,3]Department of Computer Science, Nawroz University, Duhok, Kurdistan Region – Iraq

**ABSTRACT**

In recent years, the need for community personality verification has increased dramatically, and biometrics are becoming very important in many daily applications. Biometrics work to verify individuals based on measurable data for their descriptions and characteristics. Biometric systems have thus been able to verify or identify a person.

Handwritten signatures are recognized in all societies, and because they are biometric, it has made signature verification an important biometric process. In this paper, several models are collected from hand signatures for a person to study the characteristics of the parity matrix for each of these signatures to find common factors between the characteristics of these models. The practical aspect summarizes the removal of all empty spaces outside the frame of the signature image to be followed by the process of unifying the dimensions and then drawing four characteristics of the matrix of the dialogues. The process is conducted on 100 samples to sign the person to draw the qualities of his signature and then find the common characteristics among those four attributes of the signatures group.

The tests on 10 people proved that adopting plastic qualities clearly distinguishes people's manual signatures. More than 80% of the signatures of people who were approved for the test were found. Thus supporting the possibility of being adopted as a biometric standard for personal verification, Matlab has been adopted to implement the software.

**Keywords**: Handwritten, GLCM, Seven Moments.

## 1. Introduction

Since the 1970s, studies and research in the automatic verification of handwritten signatures have been initiated as an essential need in the field of biometrics and handwriting recognition. In 1970, the first studies on the subject of automatic verification of personal signatures [1] [2] 3]]. The technical development and increased computing power of electronic devices and equipment contributed to solving many problems and were the most difficult to face. In the 1990s, the process of compiling databases that accommodate the largest amounts of data with the ability to deal with more complex works, such as artificial neural networks

(ANN) and the Hidden Markov Model (HMM), can be used to analyze those signatures. These actions and other important contributions continued until 2000 [4]. Recently, the ever-increasing demand for security systems in many daily applications and the development of signature acquisition technologies have given new perspectives in this field. The first international verification contest (SVC2004) was presented at the First International Conference on Biometric Documentation (ICBA 2004) [5]. This competition was the starting point for many competitions that began to be held, and the most important conferences in this area are the International

Conference on Document Analysis and Recognition (ICDAR) [6] and the International Conference on Handwriting Recognition (ICFHR) [7]. These competitions were of vital importance as they allowed researchers to compare their systems' performance with others and test their algorithms with standard databases that became available to the whole community. Automatic signature verification systems are designed by hand to distinguish real signatures from forgery. Handwritten signatures are one of the behavioral biometrics by observing the signature aspects and how they are likely to be adopted as signs for the author, for example, the age of the signatory, his home country, his physical, psychological, and emotional state, and the circumstances in which the signature process takes place[3]. All these factors enable the regime to reject the false signatures and accept the real ones.

**2. Self-verification of manual signing and challenges**

Even though it has been an active field of research in recent decades, there are still many open challenges in the automatic verification of a handwritten signature; analyzing the actual challenges of the field is an essential step for understanding the field's needs. An up-to-date survey of new developments and open challenges in this area, including the development of A / D converter devices, from traditional tablets, modern handheld digitizers, Personal Digital Assistants, and mobile computing input devices, Need to adapt to the data obtained from different devices a new problem must be addressed. This is one of the most important issues related to the acquisition of signatures [8].

There are several ways to perform a signature verification system that can be evaluated. Since the signature verification problem is a two-problem problem, typical errors used in binary workbooks have

historically been used to evaluate the performance of signature verification systems, including:

- False rejection rate (FRR). FRR is interested in rejecting actual signatures.
- False admission rate (FAR).

EER, which can be defined as the error rate in the system at FRR, is equal to FAR and is usually considered a measure of the total error of the verification system. Based on FRR and FAR, these measurements describe the system's ability to distinguish between real and false signatures, including TPR: True Positive Rate (FPR: False Positive Rate), where the minimum TPR and FPR with FRR and FAR through TPR = 1 - FRR and FPR = FAR.

**3. The Idea of Research**

The research aims to build a self-verification system for manual signatures. It is tested by a number of measures, such as FRR, FAR, TPR, and FPR, which are applied to a set of manual signatures collected through a manual scanner and digital camera. To four character traits.

**4. Previous works:**

Srihari et al. [9] In 1989, three algorithms were distinguished from distinguishing them:

• Template matching algorithm: Input size is adjusted to 16 X 16 to be a standard size, and Hamming distance is calculated into a set of measured initial models of the same size. The number of models has reached more than 18,000, and the algorithm has proven to increase the verification rate as the number of models increases.

• Hybrid statistical and structural work: The workbook uses features derived from the perimeter lines and is segmented by a 5 × 5 grid and determines whether or not there is a horizontal, vertical, hole, point, endpoint, or small or large concave hole in each cell.

• Structural function using features such as size and sleep mode: This method calculates bending at each

point along the outer and inner periphery of the binary image. Eight features are defined based on the amount of bending at any point.

Kimura and others developed a statistical classification technique [10] [11] that used a graph to guide the specific direction of character parameters. Even though this method was produced to identify Chinese characters, the method can be modified to identify the numbers.

In 2014, Parodi, M [12] introduced a system of manual automatic recognition of manual signatures to support criminal investigators based on the self-extracting of the property set owned by the signature holder.

M. Parodi, M., and Gomez, J.C. [13] They presented a method of verifying the validity of the online signature through the analysis of the consistency of group combinations and the recognition of patterns using the multi-border type Legendre, At the World Conference on Pattern Discrimination held in Stockholm (Sweden) in 2014, Terissi, L. and others [14] presented a search for automatic signature verification using lip-reading techniques using waveform conversion in the classification and random classification of forests.

## 5. The Property of Fixed Permanence

It has become a means of classifying things over the past half-century. It has been adopted mainly in character recognition systems and in the field of geometric shapes. The advantage of this feature is that it remains stable when the scale changes, rotates or scatters the image at any angle. However, it is affected by the different light conditions during the shooting and is therefore affected by the intensity of the contrast. Constant momentum is calculated from the center coordinates of rows (2 and 3) as the central torque represents the nonlinear interdependence of the central zodiac [15].

f(X, y) and the units of the two-dimensional image units (x, y), the continuous two-dimensional f(x, y), and the regular momentum (m) can be represented as p (q) The following [21]:

$$M\,pq = \int_{-\infty}^{\infty}\ \int_{-\infty}^{\infty}\ x^p y^q f(x,y)dxdy \ldots\ldots\ldots\ldots. (1)$$

If p,q 0,1,2......

M represents the regular torque.

The order of uniform torque is equal to (p + q).

In a specified portion of the level (x-y)

The fixed pitch of all degrees is present.

It can be expressed as regularity at a specific point, such as the center as follows:

$$\mu_{pq}\int_{-\infty}^{\infty}\ \int_{-\infty}^{\infty}\ (x-\underline{x})(y-\underline{y})f(x,y)dx\,dy \ldots\ldots. (2)$$

$$\underline{x} = \frac{m_{10}}{m_{00}} \ldots\ldots\ldots\ldots\ldots\ldots.. (3)$$

$$\underline{y} = \frac{m_{01}}{m_{00}} \ldots\ldots\ldots\ldots\ldots\ldots.. (4)$$

x towards the axis of the standard representing the center of the image $\underline{x}$.

y direction of the axis representing the center of the image: $\underline{y}$.

$m_{00}$ represents the average values of the display units.

The numerical function becomes the equation as follows:

$$\mu_{pq=\Sigma_x}\ \Sigma_y\ (x-\underline{x})^p\,(y-\underline{y})^q\,f(x,y)\ldots\ldots\ldots\ldots(5)$$

As:

x represents the X coordinate of the unit.

y represents the coordinates of the unit.

f (x, y) represents the image's intensity.

Applying equation (5) can calculate the centralization of the three classes (1st, 2nd and third). The standard centralization can be found as follows:

$$n_{\rho q} = \frac{\mu_{pq}}{\mu_{00}^{y}} \dots \dots \dots \dots \ (6)$$

Where n represents the standard central torque value (p + q).

y = 0.5 * (p+q) +1 …………. (7)

Where p + q = 2,3, ......

**5.1 Adjective and Plasticity**

Binary images may contain many disadvantages. In particular, the binary areas produced by the simple noise threshold are distorted. The treatment of morphological images seeks to remove these defects by calculating the shape and structure of the image. The processing of morphological images can be defined by a set of nonlinear processes related to the morphological form or morphology of the properties in the image. Morphological processes depend only on the relative order of the optical point values, not on their numerical values, and are, therefore, particularly suitable for binary image processing. Some of the processes used in image processing include:

Erosion & Dilation is a morphological process used in image processing that deals with the object and is the basis for the opening & closing processes. The Erosion process makes the object on which it is applied smaller by deleting the dots from its edges.

The Dilation process makes the object to which it is applied larger by adding the dots to its edges using masking, a square matrix (n * n) of units, and zeros. With this matrix, the direction of Dilation or Erosion is controlled because it may be horizontal, vertical, or Two-way adjustment of the image to be processed

The other type of morphological process is Opening & Closing. The processes linking and separating objects in the image combine the previous processes. Opening requires one or more Erosion processes and only one process of the Dilation process, thus extending the spaces between the objects, i.e., separating them. Either the Closing process requires one or more processes of Dilation, and once the process of Erosion, it works to close the spaces between objects that connect any objects. The characteristics of the adjoining matrix can be summarized in Table (1) [16].

Table (1) Characteristics of the presence matrix

| Adjective | Discerption | Mathematical formula |
|---|---|---|
| 'Contrast' | Displays a scale for the intensity of the pixel between the pixel and its entire image | $\sum_{i,j} \|i - j\|^2 p(i,j)$ |
| 'Correlation' | Returns a measure of how close the pixel is to its neighbor on the entire image | $\sum_{i,j} \frac{(i - \mu i)(j - \mu j) p(i,j)}{\sigma_i \sigma_j}$ |
| 'Energy' | Returns the sum of square (GLCM) elements | $\sum_{i,j} p(i,j)^2$ |
| 'Homogeneity' | Returns a value that measures the proximity of the distribution of elements in the GLCM to the diameter | $\sum_{i,j} \frac{p(i,j)}{1 + \|i - j\|}$ |

**6. Suggested Algorithm**

The proposed algorithm consists of two main phases:

A) The acquisition and storage phase of qualities can be summarized in the following steps:

• Initial treatment followed by adopting the plastic qualities mentioned in the sixth.

• Remove the blank photo frame Blank Truncation

• Calculate the seven images of the signature

• Calculate the parity matrix for the signature image and then calculate the four attributes mentioned in Table (1).

• Store the seven and four attributes within the database.

B) Phase of discrimination and verification: - The following steps can be summarized

• Initial treatment followed by adopting the plastic qualities mentioned in the sixth.

• Remove photo frame vacuum Blank Truncation:

• Calculate the seven images of the signature

• Calculate the parity matrix for the signature image and then calculate the four attributes mentioned in Table (1).

• Perform a correlation between the calculated seven atoms plus the four attributes with the stored database to obtain the convergence vector.

• To find the constraint that has received the highest percentage close to its adoption as the required signature.

**7. Practical Example**

• Acquisition of the signature (from any means of input as a scanner or digital camera ... etc) as in Figure (1).



Figure 1: A signature form as its initial form

• Perform the initial treatment by removing all the spaces surrounding the signature, adopting a white ground for the signature image, applying the filter type median filter, and then using the plastic qualities to fine-tune the signature image as in Figure (2).



Figure (2) A signature form after initial treatment

• Calculation of the Seven Signatures of the processed signature image as in Table (2)

Table (2) The seven to the seventh place after the decimal point

| The instinct | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th |
|---|---|---|---|---|---|---|---|
| Torque) x (10 ^ -7) | 154 | 1.83 | 0.7 | 0.0713 | 0.0012 | 0.00076 | 0.00002 |

• Calculate the four characteristics of the parity matrix as shown in Table (3)

Table (3) Characteristics of the Relationship Matrix

| Characteristics of the adjoining matrix | Contrast | Convergence | Energy | Homogeneity |
|---|---|---|---|---|
| Calculated value | 2.48731 | 0.06612 | 0.2131 | 0.60138 |

## 8. Results Discussing

Figure (1) shows the extent of the relationship between the size of the signature and the amount of momentum. Signature models have been adopted. The number of optical dots is (200-800) light points and shows that the relationship is directly proportional to the size of the signature and the amount of the verification ratio, Especially at the instinct of 1, 2, 3, 4, while the other moments are very few. As for Figure (2), the same models were used in Figure (1) to show the relationship between the signature sizes and the four characteristics of the parity matrix and gave a similar correspondence to the relationship between the signature size and uniformity.

Table (4) shows the relationship between the validity of the correspondence between the signatures of different models in a sample of (100) signatures. FRR, FAR, TPR and FPR showed that the amount of verification reaches a high percentage where the correct verification amount (when the signature was returned to the intended person) increased to 88%. The other measures can be observed in the above Table.

Table (4) Metrics {FRR, FAR TPR, and FPR} for a sample of (100) signatures

| Scale | FRR | FAR | TPR | FPR |
|-------|-----|-----|-----|-----|
| Value | 18% | 85% | 88% | 24% |

## 9. Conclusion

The experiments applied to a sample were found in live signatures of a group in which the signature images were quadrangular with longitudinal elongation and on several axes, in addition to the presence of signatures horizontally, and others were inclined horizontally at different angles. Some of these conclusions can be summarized as follows:

• The algorithm adopted is not affected by the degree of the sign slope of the horizontal axis.

• The algorithm is not affected by the size of the signatures.

• The four-figure of signature image does not affect the detection rate of the signature

• The hybridization between the seven atoms of the signature image with the four characteristics of the correlation matrix was positive. This was achieved through the great convergence of results for both methods.

• The need to adopt some of the qualities of plastic to refine the signature image, along with removing all external fumes in the form of a signature.

## 10. Future Work

The ideas presented in the research can be tried in the ways: -

• Discovery of water bodies' characteristics

• Cutting images by acquiring areas of interest (ROI)

• Study the impact of high-frequency image properties when disassembled using wavelet conversion.

## References

[1] J. Sternberg," Automated signature verification using handwriting pressure", WESCON Technical Papers, 1975.

[2] R.N. Nagel and A. Rosenfeld, "Computer detection of freehand forgeries", IEEE Trans Computers, 1977.

[3] N. Herbst and C. Liu," Automatic signature verification based on accelerometry", IBM J, 1977.

[4] R. Plamondon and S.N. Srihari," On-line and off-line handwriting recognition, IEEE, 2000.

[5] Asaad, Renas Rajab. (2014). An Investigation of the Neuronal Dynamics Under Noisy Rate Functions. Thesis (M.S.), Eastern Mediterranean University, Institute of Graduate Studies and Research, Dept. of Computer Engineering, Famagusta: North Cyprus.

[6] M.I Malik, M. Liwicki, L. Alewijnse, W. Ohyama, M. Blumenstein, and B. Found.,"competitions on signature verification and writer identification for on- and offline skilled forgeries" , 12th International Conference on Document Analysis and Recognition, 2013.

[7] F. Vargas, M.A. Ferrer, C.M. Travieso, and J.B. Alonso,"Off-line signature verification based on high pressure polardistribution". In 11th Int. Conf. on Front. in Handwriting Recognit, 2008.

[8] D. Impedovo, G. Pirlo, and R. Plamondon," Handwritten signature verification: New advancements and open", 13th Int. Conf. on Frontiers in Handwriting Recognit., Italy, September, 2012.

[9] S. N. Srihari, E. Cohen, J. J. Hull and L. Kuan," A system to locate and recognize ZIP codes in hand- written addresses", *IJRE* 1, 1989.

[10] F. Kimura, K. Takashina, S. Tsuruoka and Y. Miyake, "Modified quadratic discriminant functions and the application to Chinese character recognition", *IEEE,* 1987.

[11].F. Kimura, S. Tsuruoka and Y. Miyake, "On avoiding peaking phenomenon of the quadratic discriminant function", 8th Int. Conf. Pattern Recognition, Paris, 1986.

[12] Parodi, M., G´omez, J.C., Alewijnse L. and Liwicki, M.," Online Signature Verification: Automatic Feature Selection vs. FHE's Choice". Journal on Forensic Document Examination, Vol. 24 (2014).

[13] M. Parodi and J.c. Gomez.,"Emerging Aspects in Handwritten Signature Verification", World Scientific, 2014.

[14] Terissi, L. Sad, G., G´omez, J.C. and Parodi, M.," Noisy Speech Recognition based on Combined Audio-Visual Classifiers", Stockholm, Sweden,2004.

[15] Asaad, R. R., Sulaiman, Z. A., & Abdulmajeed, S. S. (2019). Proposed System for Education Augmented Reality Self English Learning. Academic Journal of Nawroz University, 8(3), 27–32. https://doi.org/10.25007/ajnu.v8n3a366

[16] Hall E.L., (1979): "Computer Image Processing And Recognition", Academic Press, Inc.

[17] Abdulfattah, G. M., Ahmad, M. N., & Asaad, R. R. (2018). A reliable binarization method for offline signature system based on unique signer's profile. INTERNATIONAL JOURNAL OF INNOVATIVE COMPUTING INFORMATION AND CONTROL, 14(2), 573-586.

[18] Asaad, R. R., Abdulrahman, S. M., & Hani, A. A. (2017). Advanced Encryption Standard Enhancement with Output Feedback Block Mode Operation. Academic Journal of Nawroz University, 6(3), 1–10. https://doi.org/10.25007/ajnu.v6n3a70

[19] Zhang and A.K. Jain, "Proceeding of the International" Conference on Biometric Authentication, volume 3072 of LNCS. Springer, 2004.