

# Fuzzy-Cellular Neural Network for Face Recognition HCI Authentication with Light Level Control

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**Abstract:** In this research, We offering a face recognition depended on human-computer interaction (HCI) .that the development in the world of computer and software and the entry of computer devices in all areas of life, Many devices are exposed to theft or loss of valuable data so you need to protect, authentication is one of the methods of protection[1]. In this research, we offering a new system for authentication and through this algorithm (CNN) modified with chaos and face recognition, use the sensor in device and fuzzy control rule. The images obtained in real time for 40 persons each person has 10 to 15 different shot face images, were the results for (FAR =0), (FRR =10%), (FER =10) and accuracy =90%, detection time is (710Milliseconds).

**Keywords:** HCI, HCI authentication, Face recognition, Cellular neural network, Fuzzy

## 1. Introduction

With huge developed and technological advances, the computer system has be a very strong machine that has been designed to produce human tasks easier. HCI (human - computer interaction) has become an important section of our lifetime .there are many types of HCI (human - computer interaction) comprise PDAs, cameras, pocket music players, two-way pagers, , GPS units, manufactory and medical devices, mobile communicators and smart watches, smartphone [2].Mobile devices are fast evolving technologies able of provision many services by a wide domain of apps during double networks such as the Internet (e.g. e-mail), play (e.g. games) and the participation of data (via Bluetooth). The increased use of mobile devices has resulted in access to sensitive and precious data so the need for secure authentication technology [3]. The use of passwords may be offered for loss or forgetting but the use of biometrics will be stronger and better. Some of the previous work in face recognition: Face Recognition using Fusion of PCA and LDA: Borda Count Approach [4] ,face recognition using Symlet, PCA and Cosine angle distance measure[5] Design and Application of Compound Kernel-PCA Algorithm in Face Recognition by (Liu Chengyuan and etal)[6]. Cellular Neural Networks for Image Analysis using Steep Slope Devices. by (IndranilPalit, Qiuwen Lou and etal)[7].

## 2. Cellular Neural Networks

Standard CNNs, known as Chua-Yang models contains of a rectangular  $Z_x$ Forders of identical-cells .Where each cell is affected by adjacent cells, less impact on the cell adjacent to the neighbor's .It can be formed in several forms, such as rectangle, hexagonal or square. In the processing of images with CNN it is possible to represent each state and input cells as pixels in an image[8] .It is possible to represent the input and initial state images to have visible information such as colors and formats ,describing by the states and outputs equations[9]:

$$\frac{dx_{ij}}{dt} = -x_{ij} + \sum_{(k,l) \in N(i,j)} A(i,j,k,l)y_{kl} + \sum_{(k,l) \in N(i,j)} B(i,j,k,l)u_{kl} \quad (1)$$

Where ( $u_{kl}$ ) inputs, ( $x_{ij}$ ) the states, and ( $y_{kl}$ ) the cell output in position ( $i, j$ ), the  $k$  and  $l$  denoting a generics cell belongs to the neighbor-hood  $N(i, j)$  of the cell at position( $i, j$ )

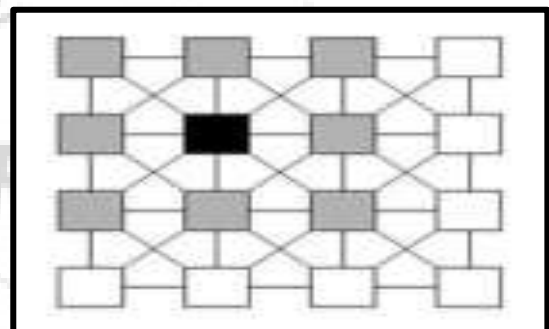


Figure 1: Cellular Neural Networks

## 3. Chaos (Henon)

In 1969, H'ennonpresent in Ref that major properties of dynamical systems knowed by differential equations can be keep by a carefully knowedregon preserving mappings. Inspired by the same concept ,H'ennon suggest the famous two-dimensional Henon map as a reduced way to study the dynamics of the Lorenz system[10]. The H'ennon map is show by the following equations:

$$\begin{aligned} ch = x_{n+1} &= 1 + ax_n^2 + by_n \\ y_{n+1} &= x_n \end{aligned} \quad (2)$$

This is a nonlinear two dimensional map, which can also be written as a two-step recurrence relation

$$x_{n+1} = 1 + ax_n^2 + bx_{n-1} \quad (3)$$

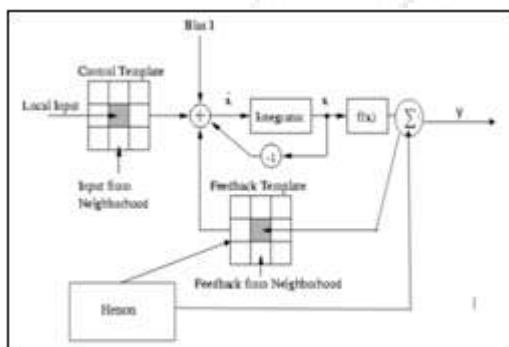
#### 4. Modified Cellular neural network with chaos

In this stage, the Modified Chaotic CNN was used to discover better face matching. Between feature in database and actual, enter face. The proposed modifications are in two locations in CNN, the first modification in the Outputs of CNN was used henon chaos system in Adding to the result (CNN) sharing in making a decision. Second modification was used henon chaos system in the learning feeding of the CNN in order to increase the learning speed and get acceptable results in stable case by avoiding Angle deviation of face image. In this stage, the second modification was used the henon chaos system in the feeding of the CNN for optimization the speeding of the learning and detection of case to find the optimal matching for two images face in face recognition system. Figure (2) shows the modification of CNN cells by adding henon chaos system in the feeding of network. In figure (2) of the feedback, templates are stored for the previous cases for finding the optimal face image

$$\frac{dx_{ij}}{dt} = -x_{ij} + \sum_{(k,l) \in N(i,j)} A(i,j;k,l) + ch \cdot y_{kl} + ch + \sum_{(k,l) \in N(i,j)} B(i,j;k,l)u_{kl} \quad (4)$$

Where the chaos is  $ch$  and:

$$ch = x_{n+1} = 1 + \alpha x_n^2 + byn \quad (5)$$



**Figure 2:** Cellular neural network with chaos

#### 5. Fuzzy Rule Control

Fuzzy control is the very important application in fuzzy theory, which uses fuzzy rules. There are three phases to produce a fuzzy controlled machine. fuzzification (Using membership functions to graphically describe a situation), rule evaluation (Application of fuzzy rules), defuzzification (obtaining the crisp or actual results). The IF part is mainly used to capture knowledge by using the flexible case, and the THEN part can be used to grant the output in linguistic changing form. This IF-THEN rule is widely utilized by the fuzzy inference system to count the grade to which the input data matches case of a rule. Three inputs and one output are used to this proposed system [11], which are shows in table (1).

**Table 1:** fuzzy rules control

Rules number	Input			Output
	CNN ratio	PCA ratio	Light ratio	
1	Lo	Lo	Lo	Flags=0
2	Lo	Lo	ME	Flags=0
3	Lo	Lo	HI	Flags=0
4	Lo	ME	Lo	Flags=0
5	Lo	ME	ME	Flags=0
6	Lo	ME	HI	Flags=0
7	Lo	HI	Lo	Flags=0
8	Lo	HI	ME	Flags=0
9	Lo	HI	HI	Flags=1
10	ME	Lo	Lo	Flags=0
11	ME	Lo	ME	Flags=0
12	ME	Lo	HI	Flags=0
13	ME	ME	Lo	Flags=0
14	ME	ME	ME	Flags=1
15	ME	ME	HI	Flags=1
16	ME	HI	Lo	Flags=0
17	ME	HI	ME	Flags=0
18	ME	HI	HI	Flags=0
19	HI	Lo	Lo	Flags=0
20	HI	Lo	ME	Flags=0
21	HI	Lo	HI	Flags=1
22	HI	ME	Lo	Flags=0
23	HI	ME	ME	Flags=1
24	HI	ME	HI	Flags=1
25	HI	HI	Lo	Flags=1
26	HI	HI	ME	Flags=1
27	HI	HI	HI	Flags=1

#### 6. The Proposed System

The proposed system is including three primary stages. First stage includes face recognition, second cellular neural network and third fuzzy control. The face recognition consists four steps pre Processing, face detection, feature extraction and face recognition or(matching). the pre Processing and face detection Integrate in one step when we use canny filter[5]. The second step is to extract features in order to identify people's faces, we must extract the distinguished attribute on the faces. generally those characteristics like eyes, nose and mouth together with their geometry allocation and using Principal Component Analysis (PCA) for feature extraction. We use 70 secondary and primary features. We use the modified CNN, which works in parallel with the system of the face recognition, where the image passing to the HCNN and PCA, the system in parallel and Each stage works separately on the image. the result of ratio for HCNN, PCA and the ratio of light sensor passing to fuzzy to take the final result either acceptance or rejection the output of fuzzy either flags=1 or flags =0. Figure .3 shows the flowcharts of proposed system

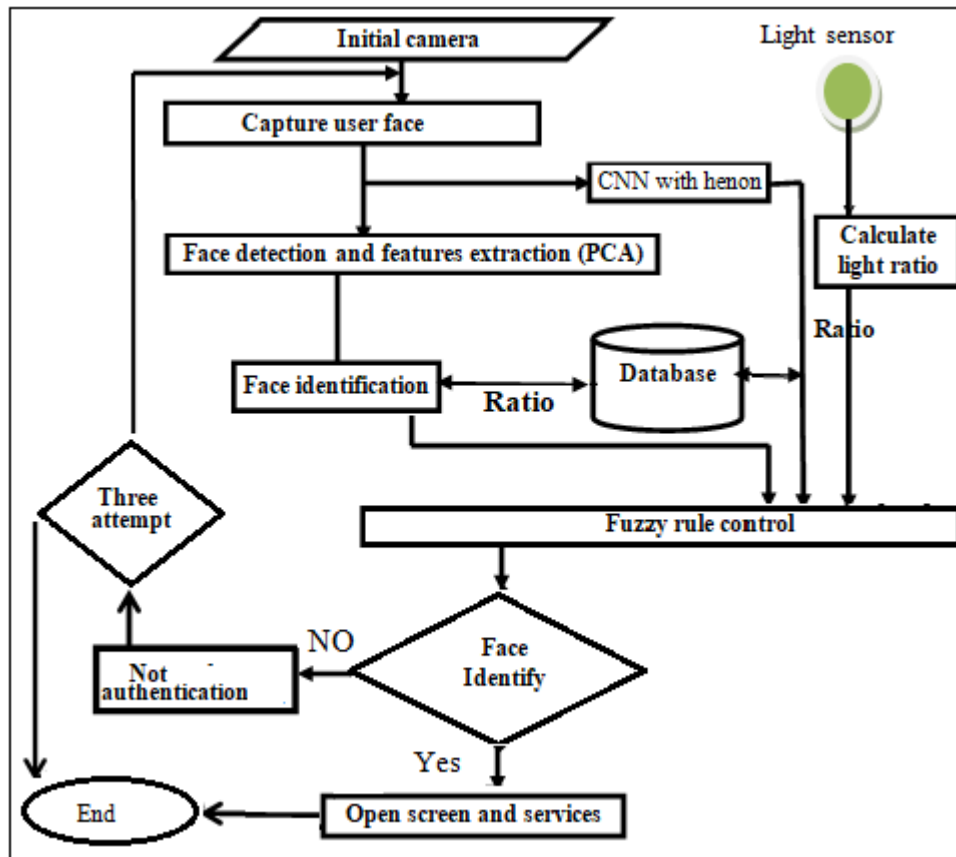


Figure 3: Flowcharts proposed system

**Algorithm (1) the proposed system Steps.**

**Input:** face image

**Output:** ratio of identification

**Steps 1:** initial camera

**Step2:** capture image and convert image to vector

**Step3:** face detection (using canny filter)

1: Smoothing removing noise by Gaussian filter with formula

$$g(m,n) = G_{\sigma}(m,n) * f(m,n) \quad \text{Where}$$

$$G_{\sigma} = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{m^2+n^2}{2\sigma^2}\right)$$

2: Compute gradient of  $g(m, n)$  using any of the gradient operations with formula

$$M(m,n) = \sqrt{g_m^2(m,n) + g_n^2(m,n)} \quad \text{And } \theta(m,n) = \tan^{-1} [g_n(m,n)/g_m(m,n)]$$

3: Threshold M: with formula

$$M_{T(m,n)} = \begin{cases} M(m,n) & \text{if } M(m,n) > T \\ 0 & \text{otherwise} \end{cases}$$

4: Suppress non-maxima pixels in the edges in MT

5 Thresholding

**Step4:** features extraction using algorithm (PCA).

1: convert face image ( $i^*j$ ) to vector ( $v$ )

2: calculate average by using Equation  $AV = \frac{1}{M} \sum_{k=1}^m \ln$

3: fined differential distance by using Equation  $U = \ln - AV$

4: Find the covariance matrix by using Equation

$$SC = \frac{1}{M} \sum_{k=1}^m U_n U_n$$

5: selected highest eigenvalue

**Step5:** Applying (HCNN) modify on result step2

**Step6:** applied Fuzzy rule control on result step 4 and step 5 and the ratio light

**Step7:** checking stage if ratio accepts then open screen and services

Else Not authentication

**Step8:** end

**7. Experimental Results**

At this stage we used smartphones such as galaxy s5 and we applied ten images person .For compute the accuracy of biometric system, error rates have to be determined and must using various execution valuation parameters. Execution parameters FAR (False Acceptance Rate) Is the percentage of the system error that accepts the number of people who are not authorized as authorized persons ,FRR (False Rejection Rate) Is the percentage of the system error that accepts the number of persons unauthorized as authorized persons,(Failure to Enroll Rate) FER the Failure to Enroll Rate is the number of persons who failure in try at registration and (recognition rate) RR or accuracy is The recognition rate .These equations show below

$$FRR = \frac{\text{number of failed attempts at authentication by authorized users}}{\text{all attempts}} \quad (6)$$

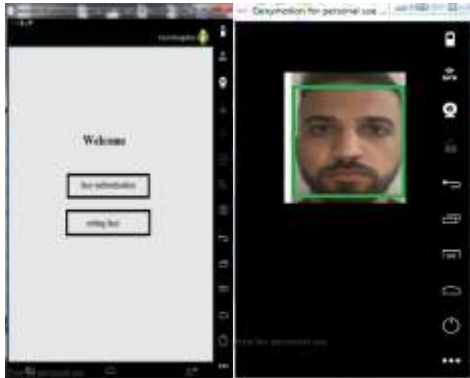
$$FAR = \frac{\text{number of effective authentications by crook}}{\text{all attempts}} \quad (7)$$

$$FER = \frac{\text{number of users who fail in their attempts at enroll}}{\text{all attempts}} \quad (8)$$

$$RR = 100 - \left( \frac{FER + FRR}{2} \right) \quad (9)$$

**Table 2:** Shows ten different shots for three people

	PCA	CNN	Propose system CNN&PCA
FAR	0%	0%	0%
FRR	20%	10%	10%
FER	40%	30%	10%
Detection time	1 second	967 Milliseconds	710 Milliseconds
ACCURACY	70%	80%	90%



**Figure 4:** The following figure illustrates the system interface

**Table 2:** Result for ten person



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