

# **Multibiometric Personal Identification based on Hybrid Artificial Intelligence Technique using Serial Mode Architecture**

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## **ABSTRACT**

In this research a multibiometric identification system with serial mode using palmprint, Dental and DNA biometric traits is proposed to identify person. A proposed system consists of three steps, first step is to create a database where all the information about the authenticated users is stored. Second step is to extract the features from a database images for palmprint and dental estimated the eigenvalues using KL transforming while the DNA data converted into ASCII code. The last step used hybrid Artificial technique combined backpropagation Neural Network and particle swarm optimization (PSO) as classifier and compare the test image with the stored information in the database. The experimental results applied cascaded (serial) mode show that the proposed system has an encouraging performance. The Genuine acceptance rate 98%, False Acceptance Rate (2%), False Rejected Rate (5%) and Recognition Rate (93%)

## **Keywords**

Index Terms –Multibiometric - serial mode-  
KL transform- backpropagation-Particle swarm intelligence-  
Verification- Identification

## **1. Introduction**

Because of the rapid scientific development in the field of technology to authenticate persons to achieve high security in all spheres of our life, and to meet the increased security requirements in a variety of applications ranging from international border crossing to accessing personal information. It must use biological traits (physical (iris, fingerprint, palm print, face, hand geometry, gait, voice. etc.) or behavioral (name, social security number, signature, etc...)) to authenticate people. Used a biometric in personal identity verification are considered more reliable, especially if you use more than one traits, because these traits do not change over time[1][2].

Most of personal identity system use only a single biometric called mono-biometric, simply called biometric

systems that cover only a single biometric trait are generally unable to provide the desired performance requirements as they suffer from problems like: noisy-data, spoof attacks, non-universality, insufficient population coverage, and improper sensor adjustment. To overcome these difficulties multi-biometric systems are used [3][4].

Using multi biometric traits to design a personal identity system capable of utilizing, more than one physiological or behavioral traits for identify person. It is generally believed that by integrating multi biometric traits into one single unit, the limitations of mono-biometric systems can be alleviated. Given that several biometric sources usually compensate for the weaknesses of single biometric fusion techniques has dealt primarily with the fusion at the score matching level [5].

The purpose of this paper is to create multi biometric personal identity system with serial mode integrating multiple traits using palmprint, dental and DNA traits to become system more reliable, These three traits sufficient to achieve the identity of the person at any time and different circumstances, either in postmortem (PM) and antemortem (AM), even if it became a long time on death. Also this system enable to universality, distinctiveness, uniqueness and permanence. The serial mode is more reliable from search in large database from different traits.

The rest of the paper is organized as follows: section 2 gives the background work from past researcher, Section 3 the overview of multibiometric system model and why used the serial mode. Section 4 fundamental of biometrics system. Section 5 suggest the overview of proposed technology, Section 6 provide the experimental result. Section 7 the conclusion the result.

## **2. Background Work**

Many researches for person authentication using multi biometric concepts with different traits are done; table (1) summarized most important researches.

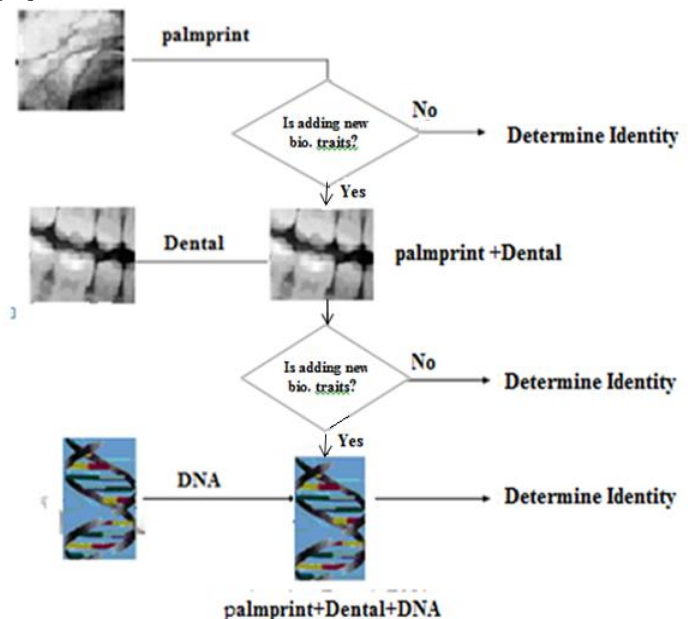
**Table 1 Related work for person authentication using multi biometric concepts with different traits**

Researcher	years	Multibiometric properties	Algorithm
Fierrez J. A., et al.	2003	Fingerprint and an online signature	Applied HMM (Hidden Markov Models) modeling of temporal functions. The classification by SVM (Support Vector Machine) [7].
Toh K.A., et al.	2004	Fingerprint, hand geometry and voice	Applied weighted-sum-rule based match-score-level fusion. In this research a local decision can be improved once threshold settings are appropriately selected for each user [8].
Snelick R., et al.	2005	Three fingerprint recognition commercial systems and one face recognition commercial system	Seven score normalization techniques (min-max, z-score, tanh, adaptive, two quadrics, logistic, and quadric-line-quadric) and fusion techniques on the normalized scores (simple sum, min score, max score, matcher weighting, and user weighting)[9].
Zhou X. , et al.	2008	Face and video gait	Present a prediction model that is based on the likelihood ratio. They derive the Fisher measurement for the sensor fusion system and matched with score Gaussian distributions [10].
Karthik N.	2008	Fingerprint and face	Used fusion methodology based on the Neyman-Pearson theorem for combination of match scores provided by multiple biometric matchers [11].
Park U.	2009	Video-bases face recognition framework using 3D face modeling technique	Used fusion scheme that combines the facial mark matching with a commercial face recognition matcher with euclidian distance to improve the recognition performance [12].
Marasco E.	2010	Multimodal biometrics system to be protected against number of vulnerable	In proposed points that may be attacked by a hacker who may choose to fake only a subset of them to improve the performance of the existing integration mechanisms in presence of degraded data and their security in presence of spoof attacks [5].
Richard Y.	2011	Face and iris images	Applied algorithms can be used to detect the subject's face, locate the eyes, reduce iris noise, segment the iris, generate a template and then identify the subject through typical pattern matching algorithms[13].
Al-Mayyan W.	2012	Signature and iris	Which combined the feature-level and decision-level fusions, have improved the final authentication performance [14].

### 3. Multibiometric System

Multibiometric system is involved one of three modes (serial, parallel or hierarchical) [15]. Serial mode, sometimes called cascade mode is used in this research. Serial mode uses more than one biometric trait. If the output of one matching operation on one biometric source is sufficient to authenticate the user, no other biometric samples are processed further. In serial mode a decision could be made before acquiring all the samples. Therefore, multiple biometric traits do not have to be captured at the same time. Furthermore, a decision could be obtained before acquiring the rest of traits. As a result, the overall recognition duration can be decreased[16]. For example, in proposed authentication system based on palmprint, dental and DNA (see figure 1). Initially the user uses the palmprint validation unit, and if this fails dental validation is applied. If the last validation is failed the DNA unit is required. The reward of such systems is that many users will enroll to the system using single trait.

The cascading scheme can improve the user convenience as well as allow fast and efficient searches in large scale identification tasks. For example, when a cascaded multimodal biometric system has sufficient confidence on the identity of the user after processing the first modality, the user may not be required to provide the other modalities. The system can also allow the user to decide which modality he/she would present first [17].



**Figure (2): Serial mode multibiometric**

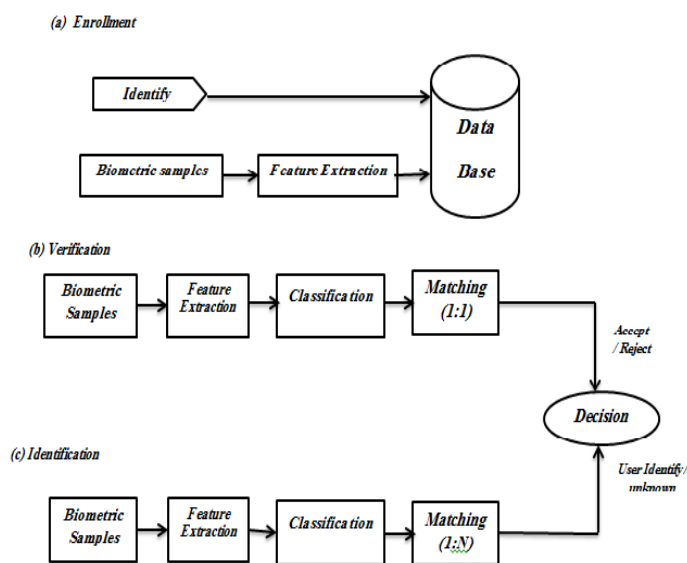
When the system is faced with the task of identifying the user from a large database, it can utilize the outcome of each modality to successively prune the database, thereby making the search faster and more efficient. Thus, a cascaded system can be more convenient to the user and generally requires less recognition time when compared to its parallel counterpart. However, it requires robust algorithms to handle the different sequence of events [17][18].

### 4. Biometrics System Fundamentals

Biometric systems can be categorized into three main functionalities as shown in figure (2), enrollment, verification and Identification [19]. During **Enrollment**, as shown in figure (2a), a sample of the biometric trait is captured, processed by a

computer, and stored for later comparison the flow of information in verification and identification”.

In **verification function**, also or sometime it is called “authentication”, see figure (2b) the user claims an identity and the system verifies whether the user claims an identity and the system verifies whether the claim is genuine, i. e., the system answers the question, the query is compared only to the template corresponding to the claimed identity (a one-to-one match)[20]. If the user’s input and the template of the claimed identity have a high degree of similarity, then the claim is accepted as “genuine”. Otherwise, the claim is rejected and the user is considered an “impostor”. In the biometric literature, the terms “client” or “authentic” are sometimes used in place of the term “genuine” [21].



**Figure (2): Biometric Functionalities (a) Enrollment (b) verification (c) Identification [20]**

Identification function, see figure (2c) refers where a person’s identity must be initially established. Acquired data associated with any person that identified is compared with stored template with database. It depending the compression (one-to-many), whose templates highest degree of similarity between the user’s inputs and the outputs by the system. Typically, if the highest similarity between the input and all the templates is less than a fixed minimum threshold, the system outputs a reject decision which implies that the user presenting the input is not one among the enrolled users [20].

## 5. Proposed Multibiometric Personal Identification System Using Serial Mode Architecture

This section explains design and implementation for the proposed multibiometric Personal Identification System and evaluation performance. It provides a brief overview of palmprint, dental and DNA traits to identification and verification any person, see figure (3)

To create a multibiometric Personal Identification System using palmprint, dental and DNA traits follow these steps:

**Step 1: Data Captured:** first step is to captured information for palmprint, dental, and DNA used as input to the system .To

captured the palmprint capturing device, setting the mode 300 dot/inch due to make the process faster. A prototype for image acquiescing is shown in figure 4. Acquiesced image is then reduced to 25% both horizontally and vertically to make the image size small. It is necessary that the hand should be placed in a relaxed state and the fingers are separated from each other’s to obtain very clear features of palm shown in figure(4).



**Figure (4): Prototype of the proposed multispectral palmprint system.**

Palm is the inner surface of hand from wrist to the root of fingers. A print impression made in or on a surface by pressure. A palmprint is defined as the skin patterns of palm, composed of the physical characteristics of the skin patterns such as lines, wrinkles, points, ridges, valleys and texture [23].

For dental images are captured from dental radiographs called panoramic. A panoramic dental radiograph is a large, single x-ray film that shows the bony structure of the dental and face. It is entirely extra oral, which means that the film remains outside of the mouth while the machine shoots the beam. The panoramic dental radiograph is a lower resolution image than intraoral film.

The DNA can be obtained from special device. In this research, DNA database are taken from National Science and Technology Council (NSTC) , Committee on Technology consist of fifty person each one has 200 samples for example Deoxyribonucleic acid (DNA) is the carrier of genetic material found in most organisms, including humans. Each individual human is identifiable by hereditary traits found in their DNA, which are located in the nucleus of the cells well as the mitochondria. DNA serves as a genetic code that is unique to every organism, no two being exactly alike. A single strand of DNA is a string consisting of a combination of four different base nucleotides shown in Figure (5):

1. Adenine: Its chemical form denoted by letter (A).
2. Guanine: Its chemical form denoted by letter (G).
3. Cytosine: Its chemical form denoted by letter (C).
4. Thymine: Its chemical form denoted by letter (T) [24].



**Figure (5) : DNA is double helix structure[25]**

**Step 2: Data Preprocessing:** The second step is preprocessing the image captured in step 1, for palmprint captured image Readed as a color image, normalize it into fixed size (256\*256) pixel and then convert colored

image of palmprint into the gray scale image according to equation (1), see Figure (6).

$$\text{Gray} = 0.2989X * R + 0.7870X * G + 0.1140X * B \dots\dots\dots(1)$$

Where R: represent red color, G: represent green color, B: represent blue color.

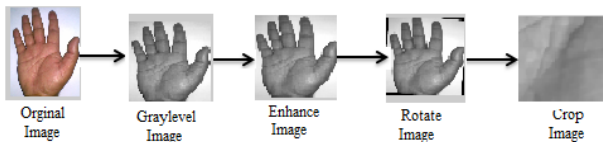
After that enhancement the image by remove noise from images with enhances filter called median filter matrix default 3-by-3 neighborhood, the median filter replaces all the image pixels in the same time with the median of the image pixel values in a predefined neighborhood of the given pixel. More precisely, if  $f(x, y)$  denotes the pixel value in the position  $(x, y)$  then the new  $f'(x, y)$  value of that position will be reckoned by Image Enhancement using Median Filters in algebraic reconstruction methods illustrate in equation 2):

$$f'(x, y) = \text{med}_{-k \leq u, v \leq k} \{f(x + u, y + v)\} \dots\dots\dots(2)$$

Where the median calculated over  $(2k+1) * (2k+1)$  window, the size of filter has same value and  $(u,v)$  represents pixel position in the filter [120]. The result of enhancement has shown Figure (6).

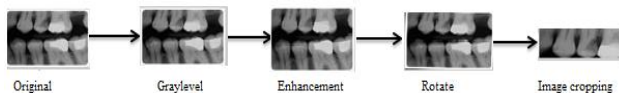
After the image-enhanced step, the images are traced to obtain the contours of hand shape by rotate the hand image through angle ALPHA counter clockwise direction around an axis described by the one-element direction vector, coordinates to be more suitable for cropping that and illustrated in the Figure (6)

The next thing done is to create a bitmap of the image by cropping means removing unnecessary borders of hand image. This is done by cloning the useful part from original image taking a rectangle of the original as shown in Figure (6).



**Figure (6): palmprint preprocessing stages**

The dental normalization stages same as stages in palmprint as shown in figure (7), at first normalized the images into fixed size (256\*128) pixel and then convert colored image of dental into the gray scale image, enhanced images (3-by-3) low pass filter called order filter, because this filter increase the sharpness and the contrast of spatially ordered detail patterns [27], and crop cropping part must consist of lateral incisors and central incisors.



**Figure (7): Dental preprocessing stages**

In DNA preprocessing there is no noise to remove, or rotation except converting the letters in to their equivalent ASCII code numbers to become more suitable for input to the to the classification step.

**Step 3 :Feature Extraction:** Feature extraction refers to the process of generating a compact but expressive digital representation of the underlying biometric trait, called a template which contains the unique data to glean only the salient information from the acquired biometric sample to form a new representation of the biometric trait, called the feature set. The template is expected to contain only the salient discriminatory

information that is essential for recognizing the person. To extract feature for palmprint and dental traits KL transform also known as the principal component transformation. Eigen value method is used set of orthonormal basis vectors. Each eigenvalue is derived from the covariance analysis of the image population. A similarity measure is then created in order to measure resemblance between images. Two images are considered to be similar if the distance between their feature vectors is small in the eigenvector feature space [28].

In Mathematic form a two dimension image can be represented as one dimension vector by concatenating each row (or column) into a long thin vector. The covariance matrix of the input data is calculated starting from the algorithmic mean of all vectors  $I_1, I_2, \dots, I_i$ .

$$\psi = \frac{1}{M} \sum_{i=0}^M I_i \dots\dots\dots(3)$$

The difference image vector  $I_i$  and mean is called with

$$\Phi_i = I_i - \psi \dots\dots\dots(4)$$

The theoretical Covariance matrix  $C$  of all  $i$  is

$$C = \frac{1}{M} \sum_{i=0}^M \Phi_i \Phi_i^T \dots\dots\dots(5)$$

All eigenvectors  $v_i$  and eigenvalues  $\lambda_i$  of this covariance matrix are derived from the relationship.

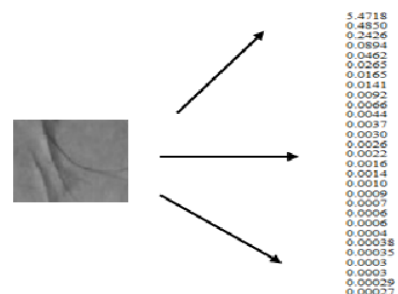
$$\lambda_i = \frac{1}{M} \sum_{i=0}^M (v_i^T \Phi_i^T)^2 \dots\dots\dots(6)$$

The collection of  $M$  eigenvectors  $V_i$  can be seen as the reduced dimension representation of the original input image. This set of eigenvectors will have a corresponding eigenvalues associated with it, which indicates the distribution of this eigenvector in representing whole dataset. The small set of eigenvalues is enough to build up the whole image characteristic.

$$\varepsilon = \sum_{i=0}^P v_i \dots\dots\dots(7)$$

Where  $P$  is number of eigenvalues.

KL transform is applied to images (palm and dental). This transformation reduce the original dimension of the image, thus the dimensions are greatly reduced and the most representative features of the whole dataset still remain within only eign features, see figure (8). While in DNA no feature extraction is used because there is no image except convert the serial number into their ASCII code.



**Figure (8): The eigenvalues extract from palmprint image.**

**Step5: Classification:** To classify images first clustered the featured that obtain from KL transform algorithm by Particle swarm optimization (PSO) algorithm, because it has been largely applied to solve optimization problems.



Classification is to be more suitable for input to the matching stage in identification or verification approach.

## 6. Verification

Verification system consists of two classes recognition assignment, where the sample is classified either genuine or not. The result with predefined allies between two values for threshold (minimum, maximum threshold) and classifies the claimer. The system accepts the claimer if and only if the value less than or equal the maximum threshold and greater than minimum threshold. ID is validated and matched with one of the images stored in the database.

Let  $D_{\text{palmprint}}$ ,  $D_{\text{dental}}$  and  $D_{\text{DNA}}$  denote the decision of the palmprint, dental and DNA respectively. The serial mode (shown in figure 9) can be obtained after training each classifier independency to take the final decision of the individual classifiers in order to find  $D_{\text{palmprint}}$ ,  $D_{\text{dental}}$  and  $D_{\text{DNA}}$  the estimated by equation (12)

$$D = (D_{\text{palmprint}} \ // \ D_{\text{teeth}} \ // \ D_{\text{DNA}}) \dots\dots\dots(12)$$

Where // mean if failure rule.

The summarized of the algorithm applied in this research

- Step 1: captured all the images samples.
- Step2: Normalize the images to become more suitable for processing, and crop these images to remove unused part of image.
- Step 3: Apply the KL transformation on the extract images to obtain eigenvalue and Eigen vector
- Step 4: Extract the global features from palmprint and dental to obtain eigenvalues, while DNA is convert into ASCII code.
- Step 5: Apply the eigenvalues those obtain in step 2 (except DNA) as input to PSO algorithm and then to the backpropagation supervisor neural network.
- Step 6: Train set of identification images the network to 30-90 epochs with epsilon equal 0.001 and save the output for network.
- Step 7 verify the image choosing any ID number belong any person in database set and train it in the same network.
- Step 8: compare the output for matching with dataset of step five, and then decide if accepted or rejected
- Step 9: if palm print rejected in decision in step 7, then apply the dental decision otherwise break the system for successor acceptable.
- Step 10: if dental rejects the decision, then apply DNA decision otherwise break the system for successor acceptable
- Step 11: if DNA is accepted then the system is accepted otherwise the system rejected.

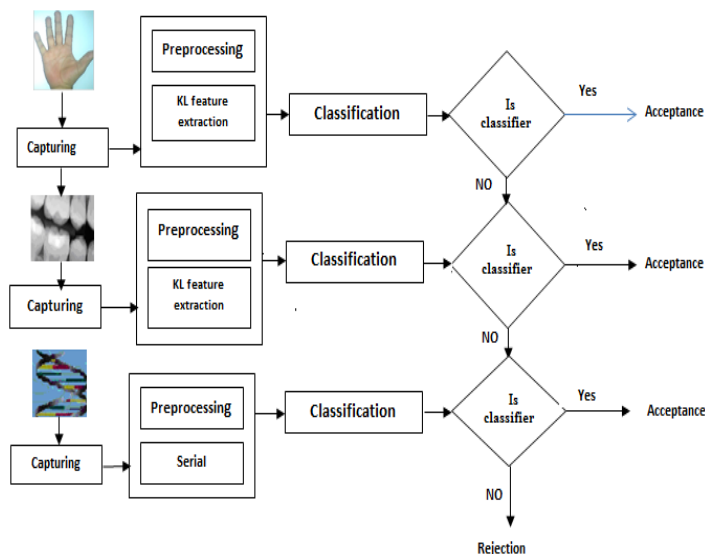


Figure (9): The proposed multibiometric system with serial mode architecture

## 7. Experiment Evaluation

In this research, a novel approach is presented to authenticate individuals by using serial multibiometric mode using palmprint, dental and DNA features. The virtual database collected from 50 different persons(eight images for each person). The hand images are captured from prototype device. The dental image captured from radiographs called panoramic (50 persons, four images for each person), while DNA captured with special device(50 person). Then do normalization images to appear suitable and comfortable for all users. The feature extraction using KL transform. Besides, we propose verification mechanisms in PSO and BP neural network-based method, to verify the system .The performance evaluation of the serial mode system four well-known measurements are used, Genuine acceptance rate (GAR), False Rejection Rate (FRR), False Acceptance Rate (FAR), and recognition rate (RR) of our proposed

- Genuine acceptance rate (GAR)(98% )
- False Acceptance Rate(FAR) (2% )
- False Rejected Rate (FRR)(5%)
- Recognition Rate (RR)(93%).

Figure (10) represented the histogram from the performance evaluation from system

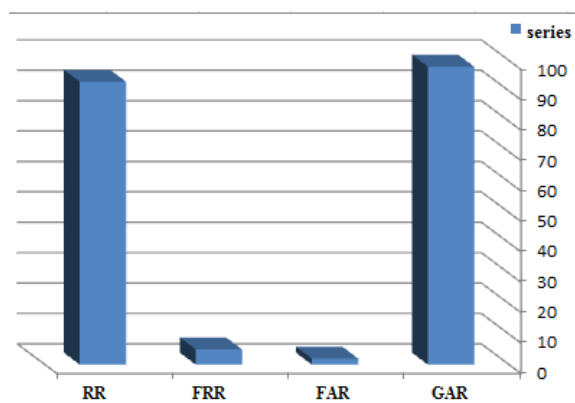


Figure (10) Histogram of serial multibiometric system

Therefore automated multibiometric system designed to identify individuals from such pieces of multiple evidences, In this research from multibiometric can effectively achieve higher performance.

## 7. Conclusion

The essential objective of this research is to examine the performance of a multibiometric system can be improved by integrating complementary information which comes primarily from three different and independent modalities ( Palmprint, Dental and DNA). This Multibiometric system uses the three traits in serial mode is a good system since it enables to capture traits for one of those traits or when there is noise. It has been demonstrated that this method is efficient due to its high success rate. It is simple since by taking when large database and if there is one image from the user we can get the features for all the unimodal biometric employed.

Using particle swarm intelligence and PB neural network called (hybrid technique) is the best solution and more effective for multibiometric systems.

In future, an attempt will be made to develop a person identification system by using multibiometric technique with parallel architecture.

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