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# Implementation of Multi-Model Biometrics Fusion Architecture for Authentication Using NN Tool

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**Abstract --** *Biometric As we know that fingerprint authentication for individual identification is a popular method of biometric system, but if we combine two or more biometric techniques then the security can be increased. Here we have used a multi-model biometric for authentication and recognition of an individual using neural network and Support Vector Machine. To overcome the security issues, my proposed approach is to combine the face recognition method and the fingerprint method of biometric system. Firstly the face from the first object will be detected then the second fingerprint object will be loaded. Secondly both the detected face and the fingerprint object image will be merged using fusion techniques and then further processing will extract their features for matching process. The last step is to classify and recognize using combined NN and SVM techniques to increase the accuracy, security and to enhance the performance over previous technique (Individually NN and SVM) will be increased compared to previous work results.*

***Keywords:*** *Multi-Model biometrics, Face, Fingerprint, MSE, PSNR, CCR*

## I. INTRODUCTION

Biometrics system uses physiological or behavioral features of an individual for the purpose of authentication and verification as shown in figure 1. There are some algorithms which help to extract the fingerprint features such as minutia based, pattern based etc. It is base on the choice of the user any algorithm can be used. A person can also be identified by his/her face also in this case facial features are extracted and matched against the database templates. But all these are Uni-Biometric techniques. Recognition of a person can also be done using Multi-biometric technique. In Multi-biometric system two or more biometric features can be combined to create a multi-model biometrics.

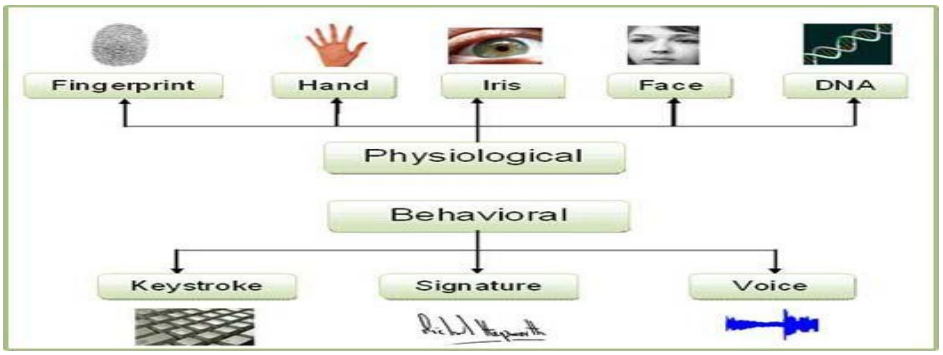


**Figure 1:** Factors of a Biometric Authentication System [1].

## II. FINGERPRINT RECOGNITION

In this biometric method we will take fingerprint image and then extract the features to be matched. If someone wants to check someone else identity, then he/she has to scan the finger suing a scanner for the fingerprints. Multiple images of the same finger have been captured. Now the retrieve fingerprints will be an image of the fingerprint and will used in the identification purpose. In this process the main concentration is to capture the centre point of the fingerprint, which contains many of the unique features. After capturing all images of the fingerprint, the next step is to binary conversion the images.

## III. FACIAL RECOGNITION

It means identification of a person by his facial characteristics. Facial recognition is one of the most common biometric methods of identification. Here facial features of a person are detected and extracted from an input image. In addition, the method of acquiring face images is non-intrusive. Two primary approaches to the identification based on face recognition are the following: (i) Transform approach[2,3]: the universe of face image domain is represented with a set of orthonormal basis vectors. Nowadays, (ii) eigenfaces is the most popular basis vector.

## IV. REVIEW OF LITERATURE

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[4] Biometric fusion are used to enhance system security, efficiency, applicability, and robustness. Some types of fusion have been used successfully for years in large scale fingerprint identification systems. [5] Combined two biometric techniques verification system fingerprint and voice. The fusion decrease privacy concerns. The Accuracy is increased in comparison of the previous results for voice verification over the same speaker database. [6] Proposes a method of authentication and identification using face and palmprint techniques. By amalgamate the palmprint and face features increases accuracy, robustness of the biometric authentication. [7] Had compared and evaluate various fusion techniques on the basis of comparison the accuracies had evaluated. [8] Described an innovative multimodal biometric identification system based on iris and fingerprint traits which used hamming distance based matching algorithm for calculating the hamming distance for the comparison of templates. [9] Presented a review of literature on some of the fusion techniques for images like, Discrete Wavelet transform based fusion, Primitive fusion, Principal component analysis (PCA) based fusion etc. [10] Deals with fusion of biometric features like iris and palmprint. The iris and palmprint are transformed into the set of features independently. The extracted modalities are fused by different fusion algorithm techniques like the pyramid based algorithms and wavelet based algorithms. [11] Here three fusion techniques (PCA, DCT & DWT) are analyzed and DWT will be established as a most suited fusion technique for multi modal biometric system of iris, palm print, face and signature. The fused image is then extracted by using Inverse Discrete Wavelet transform. [12] Fusion of fingerprint, iris and face traits are used at decision level in order to improve the accuracy of the system. Each subsystem gives its individual binary decision (either low or high), and then these decisions are fused using Fuzzy and weighted logic. Experimental results show that weighted fuzzy logic gives excellent accuracy equal to 99.99 %.

## V. PROPOSED MODEL

As in fingerprint matching technique matching algorithms compare the previously stored image templates against a candidate fingerprints for authenticity. My proposed work is same but with multi-biometric system model using NN_SVM. In this proposed algorithm my concentration is on physiological fingerprint and face recognition methods. I have considered both objects as images, fused and stored those images in a database as templates. Whenever we have to check the authenticity of a person we will scan his fingerprint and photo using a scanner/digital camera. These new objects will be fused and compared with our created database using NN and SVM. The complete process of this proposed work is divided into three main modules load module, Fusion module and the Matching module as shown in figure 2 .

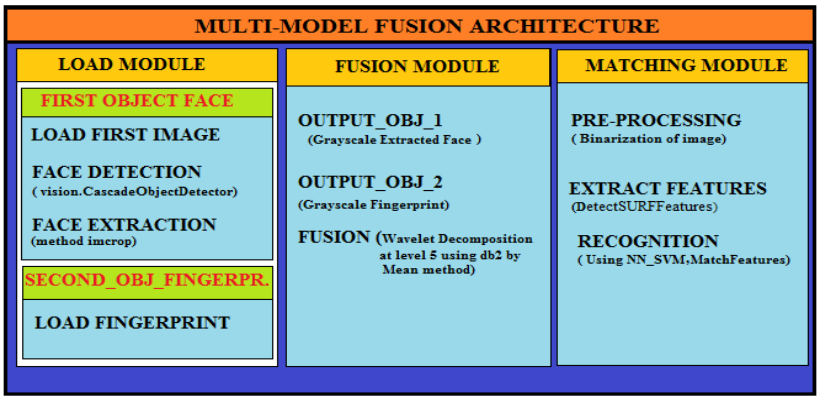


**Figure 2:** Multi-Model Biometric Fusion Architecture

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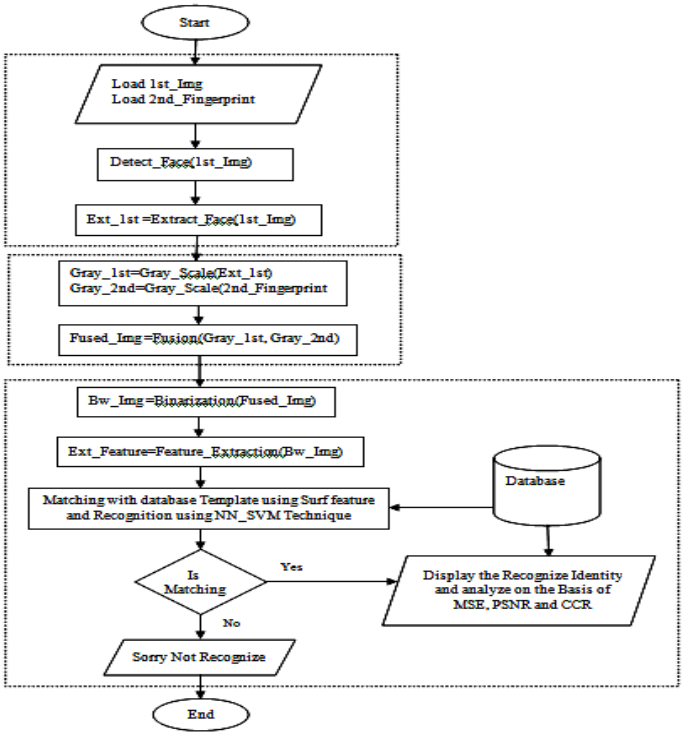


**Figure 3**: Flowchart of proposed work.

## VI. RESEARCH METHODOLOGY

This is the methodology used to implement the proposed model foe biometric fusion.

### 6.1 Neural Network (NN)

Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the connections between elements largely determine the network function. You can train a neural network to perform a particular function by adjusting the values of the connections (weights) between elements. In addition to function fitting, neural networks are also good at recognizing patterns. nprtool leads you through solving a pattern-recognition classification problem using a two-layer feed-forward patternnet network with sigmoid output neurons. Finally we will analyze the results between fused images and recognized using MSE and PSNR and CCR [13].

### 6.2 Support Vector Machine (SVM)

SVM is mainly a two-class classifier. Width of the margin between the classes is the optimization criterion, i.e. empty area around the decision boundary defined by the distance to the nearest training patterns. These patterns, called support vectors, finally define the classification function. Their number is minimized by maximizing the margin. The support vectors replace the prototypes with the main difference between SVM and traditional template matching techniques is that they characterize the classes by a decision boundary. Moreover, this decision boundary is not just defined by the minimum distance function, but by a more general possibly nonlinear, combination of these distances.
Commonly used kernels include:-

a) Linear Kernel
$$K(x, y) = x, y \quad \text{.....(1.3)}$$

b) Polynomial Kernel
$$K(x, y) = (x. y+1)\ d \quad \text{.....(1.4)}$$

The Support Vector Machine concept was introduced by Vapnik. The objective of any machine that is capable of learning is to achieve good generalization performance, given a finite amount of training data, by striking a balance between the goodness of fit attained on a given training dataset and the ability of the machine to achieve error-free recognition on other datasets.
SVM principle is to map the input data onto a higher dimensional feature space nonlinearly related to the input space and determine a separating hyper plane with maximum margin between the two classes in the feature space. A support vector

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machine is a maximal margin hyper plane in feature space built by using a kernel function. This results in a nonlinear boundary in the input space.

**SVM Algorithm**

**Algorithm** Simple SVM
CandidateS-{closest pair from opposite classes}
**While** there are violating points **do**
Find a violator
candidateS=candidateSUviolator
**if** any αρ<0 due to addition of c to $ **then**
candidateSV = candidateSV\p
repeat till all such points pruned
**endif**

## VII. IMPLEMENTATION AND RESULTS

Here I have used MATLAB 12.0 GUI for my experiment and results. When I tried to check the authenticity of a person using my multi-biometric system model then I found, that it always provides good (CCR%) results in comparison to NN and SVM individually and we also find improvements in MSE and PSNR values. Let us see the working of all the modules and the results of this research work.

### 7.1 Load module

This module is divided into two segments (First Object Face and Second Object Finger).

**First Segment (First_Object_Face)**

1. The first step of this segment is to load the First Object.
2. Face detection.
3. Face Extraction.

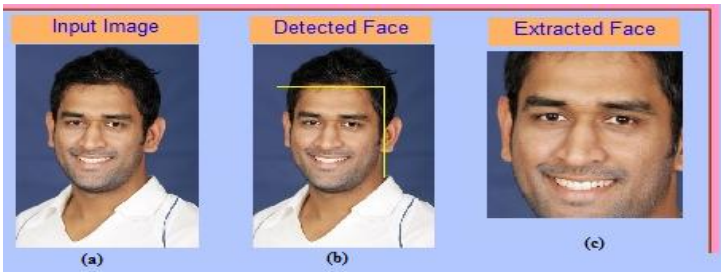


**Figure 4:** (a) loaded image (b) Detected face (c) Extracted face

**Second Segment (Second_Object_Fingerprint)**

1. Load the Second Object, as shown in figure 5.


**Figure 5:** Loaded Fingerprint of the same person.

### 7.2 Fusion Module

1. Now take both the loaded objects as shown in figure 6.

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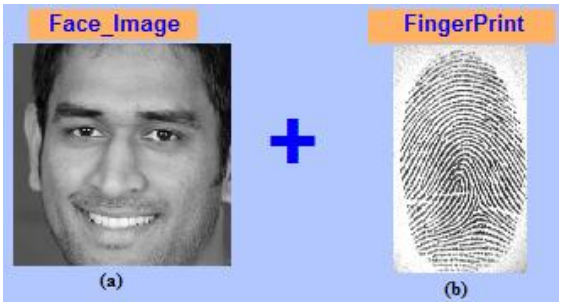


**Figure 6:** (a) first image (Extracted face) (b) second image ( Loaded Fingerprint).

2. Apply the Fusion technique. Here I have used wavelet decomposition at level 5 by db2 using 'mean' method. Save the fused object to the database.
3. 

wfusimg(bgImg,fgImg,'db2',5,'mean','mean');
bgImg= Background Image fgImg=Front Image

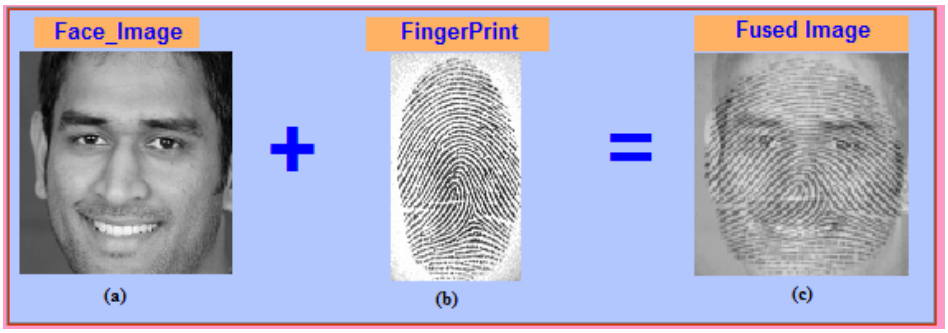


**Figure 7:** (a) Extracted Face (b) Fingerprint (c) Fused Image

### 7.3 Matching Module

1. Preprocessing will be done on the fused object here the fused object will be converted into binary (b/w, 0/1) image. As shown in figure 8(a).
2. After binary conversion the main features will be extracted for matching purpose using Surf feature and Extract feature methods figure 8(b).

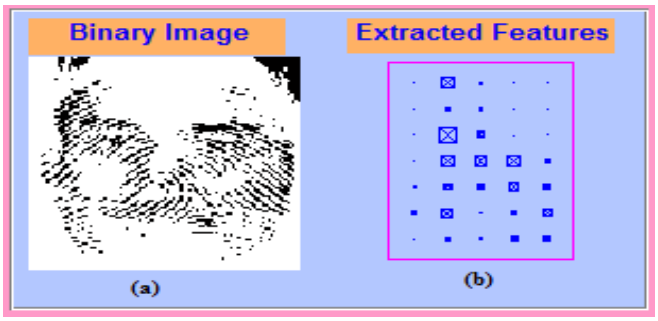


**Figure 8:** (a) Binary Image (b) Extracted Features

```
points1=detectSURFFeatures(Image);
[feature,valid_points1]=extractFeatures(Image,points1);
```

3. Match extracted features with database template and recognize using proposed technique (NN_SVM method) as shown in the figure 9.

```
nnstart;
```

```
df1=dlogsig(n1,A1(:,i));
df2=dlogsig(n2,A2(:,i));
s2 = -2*diag(df2) * e(:,i);
s1 = diag(df1)* W2'* s2;
W2 = W2-0.1*s2*A1(:,i)';
b2 = b2-0.1*s2;
W1 = W1-0.1*s1*P(:,i)';
b1 = b1-0.1*s1;
A1(:,i)=logsig(W1*P(:,i),b1);
A2(:,i)=logsig(W2*A1(:,i),b2);
error =0.5*mean(mean(e.*e));
mse=error;
```

(a)

```
p=10*log(10);
psnr(i)=p*(((255).^2)/mse);

trainset=[(1:20);(51:70);(101:120)];
testset=[(21:50);(71:100);(121:150)];
```

(b)

**Figure 9**: **(a)** Defining weight to I/O neurons. **(b)** calculating PSNR values and preparing train and test sets.

```
Iteration  :  1236          mse  :      0.024675
Iteration  :  1237          mse  :      0.024626
Iteration  :  1238          mse  :      0.024577
Iteration  :  1239          mse  :      0.024528
Iteration  :  1240          mse  :      0.024479
Iteration  :  1241          mse  :      0.024431
Iteration  :  1242          mse  :      0.024382
Iteration  :  1243          mse  :      0.024334
Iteration  :  1244          mse  :      0.024285
Iteration  :  1245          mse  :      0.024237
Iteration  :  1246          mse  :      0.024189
Iteration  :  1247          mse  :      0.024141
Iteration  :  1248          mse  :      0.024093
Iteration  :  1249          mse  :      0.024045
Iteration  :  1250          mse  :      0.023997
Iteration  :  1251          mse  :      0.023949
Iteration  :  1252          mse  :      0.023902
Iteration  :  1253          mse  :      0.023854
Iteration  :  1254          mse  :      0.023807
Iteration  :  1255          mse  :      0.023760
Iteration  :  1256          mse  :      0.023713
Iteration  :  1257          mse  :      0.023666
Iteration  :  1258          mse  :      0.023619
Iteration  :  1259          mse  :      0.023572
Iteration  :  1260          mse  :      0.023525
```

**Figure 10:** NN iteration and MSE values.

```
index_pairs=matchFeatures(feature1,feature2);
[a_d b]=size(index_pairs)
```

4. Display the outcome and analyze on the basis of MSE, PSNR and CCR values.


**Figure 11:** Final Result identity exists.

Calculating Mean Squared Error (MSE) and Peak Signal to Noise Ratio (PSNR) Values.

$$MSE = \frac{\sum_{M,N} [I_1(m,n) - I_2(m,n)]^2}{M * N} \quad \ldots.(i)$$

$$PSNR = 10 \log_{10} \left( \frac{R^2}{MSE} \right) \quad .....(ii)$$

I1= first input Image I2=Second Input Image M= Rows , N= Columns
R= 255

**Table 1:** showing the MSE and PSNR Values

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| | MSE | PSNR |
|---|---|---|
| Proposed | 7.8822e-04 | 3.7991e+09 |

**Table 2:** Cumulative Match Score of all Strategy

| | CCR% |
|---|---|
| Proposed | 101.0008 |
| NN | 99.0008 |
| SVM | 97.0008 |

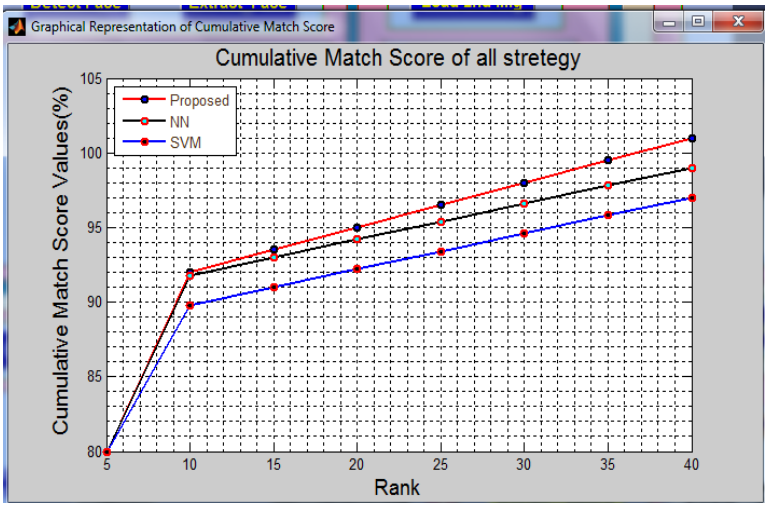


**Figure 12:** Cumulative Match Score of all strategy.

## VIII. Conclusion

Biometric technology provides a strong method of linking persons to identify records.
But we know that if we combine to biometric techniques then it will definitely give us good results, even better than single biometric. That's why I have planned for this multi-biometric system model and for this research work I have taken face and fingerprints of a person then fused the images into one and stored the fused features into the database. Compared with other existing systems, the proposed method (NN_SVM) of personal authentication has merits of high accuracy, high performance in-terms of CCR (%) small size and cost-effective.

## IX. ACKNOWLEDGE

Thanks to my research supervisor and family member who always support, help and guide me during my dissertation. Special thanks to my father who always support my innovative ideas.

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