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Hand Geometry Recognition System

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ABSTRACT: Human biological characteristics such as fingerprints and iris scanning have taken over the role of passwords, secret codes, and identification cards as the primary means of individual identification in today's technologically advanced world. The geometric structure of the human hand has distinctive qualities that make it a valuable biometric feature for identification and verification. This paper presents a useful biological approach for hand geometry- based recognition systems. Measurable hand geometry such as width, length, and finger area, were used to generate feature vectors. As useful properties, thirty- five hand-shaped geometry scales are used. Artificial neural networks are used as distinct classifiers. The experimental result of all dataset reaches to the performance of 98.30% as recognition rate.

Keywords: Pattern recognition, Hand geometry, Biometric, Artificial Neural Networks

1. INTRODUCTION

Biometric recognition systems utilize a person's physical traits for automated identification. Biometric recognition technologies have shown to be incredibly precise and efficient in a wide range of applications. The manually constructed authentication method may be used to regulate access in medium- and high-security locations, as well as to increase confidence in extremely high security sites when combined with additional biometrics like fingerprints [1].

Geometric characteristics of the hand, such as the width and length of the fingers, the diameter and circumference of the palm, are used in hand identification systems. The human hand is what determines the geometry of the hand, and at a certain age, the human hand doesn't change that much. The human hand is not unique, unlike many other biometrics, and is therefore considered a measure of life. When combined with other finger and hand features and measurements, Systems for hand recognition are reliable for verification [2]. Naturally circular geometry units of measure provide estimates for various scales, including finger width. The mechanical or mechanical industry or that often underlies these technologies. The anatomy of the palm provides the basis for the geometry of the hand [3].

The two steps of a biometric system's procedure are typically enrollment and verification [4].

A. The registration process involves adding a new user to the database or updating the feature vector for the current user. The stage consists of three modules: image acquisition, image preprocessing, and feature extraction.

B. The verification stage includes comparing a hand with a person already registered in the database of system.

Each of the five biometric system modules shown in figure (1).

The steps of the proposed hand geometry recognition system are addressed in previous work [5]; effective outcomes have been obtained. The same extracted features presented in the previous work are used in this work to examine the performance of the hand recognition system when reduce output nodes.

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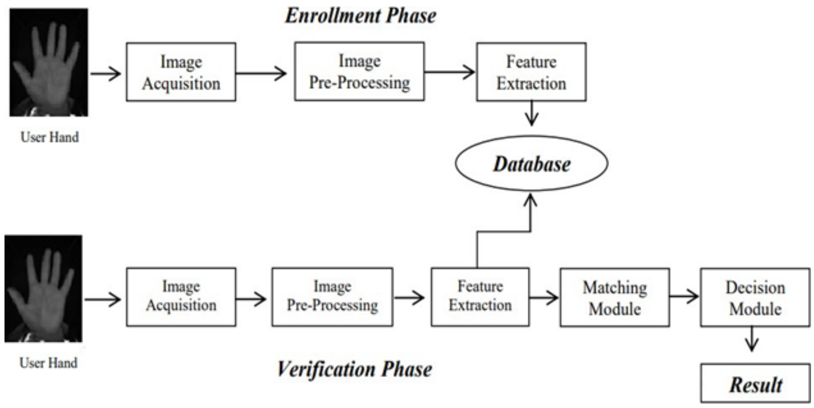

FIGURE 1. **The process of Biometric Systems.**

2. METHODOLOGY

The hand recognition system design framework technique was put into practice in MATLAB R2021a environment. The acquisition of images from the CASIA database and the use of image pre-processing algorithms constitute the first stage. The second stage involves extracting biometric characteristics from the hand photos. Implementing the neural network, which is the suggested alteration to the current system, is the third and final stage. The hand biometric recognition systems for automated recognition systems utilize a person's physical characteristics. The proposed methods in [5] are tested in this study under the second experiment.

Image Acquisition: To create a template database, the hand picture is used from the Multi-Spectral Palmprint Image Database of CASIA.

Image Pre-processing: processing stage is very important in biometric systems to remove obstacles that reduce the quality of the extracted properties. The image processing processes included in the preparation substage include image rotation and cropping, image smoothing using median filter, binarization to produce black and white image (also known as the Otsu technique), employing the flood-fill to fill all gaps appeared in binary image, edge detector to detect boundary of hand, and thinning to reduce the thickness of hand edge.

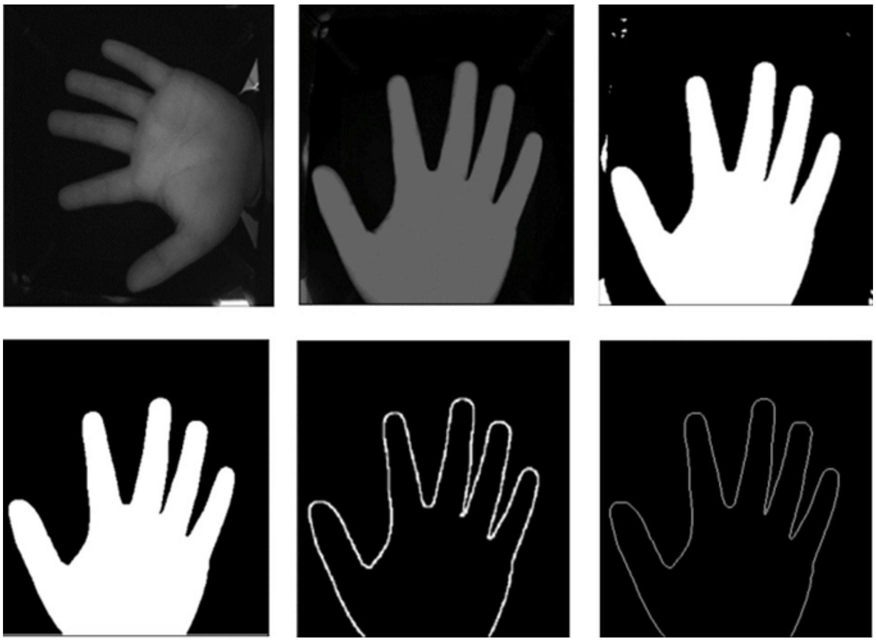

FIGURE 2. **Image Pre-processing Modules.**

Chain Coding: Chain coding is used to represent just linked lines of the hand in order to prepare the hand picture for feature extraction.

Feature Extraction: In this research, 35 geometrical features, such as width, length, perimeter, and palm distances based on measuring the distance between the fingers and the palm, have been presented to describe a single hand. Each extracted feature list is put together as a feature vector, which is then utilized to separate various people. These attributes consist of:

- Finger lengths (5 features).
- Finger widths (20 features).
- Perimeter (5 feature).
- Palm Inter-point Distance (5 feature).

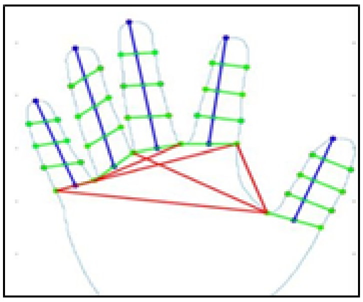

FIGURE 3. **All Features Extracted.**

Feature Selection: PSO was used in this work to develop the most discriminatory features while reducing the amounts of characteristics.

Create Classifier: Artificial Neural Networks (ANNs) are used in this step to learn about the properties retrieved and saved in the databases. The proposed ANN is the frequently used supervised learning neural network. A training set (output/input pairs) is required for back-propagation. Initially small random weights are used [6]. The weights are maintained by correcting the learning mistake after comparing the supervised learning outcomes. The error function can be reduced by gradient descent. Benefits: Works very fast. A neural network is made up of artificial neurons, also known as nodes, that are built up in layers. An inverse neural network generally has three layers: input, hidden, and output [7]. In this work, the input layer had 26 nodes to represent the number of most discriminant features, while the output layer had 7 neurons to represent the seven bits. In this experiment, we reduced the number of nodes in the output layer from 100 to 7. To build the best possible classifier, several tests were performed for different parameters in our experiment. Works require two levels: training and testing. The data is split into training and testing, with 70% of the data used for training and 30% for testing. We modified the parameters of the neural network in this study to obtain a satisfactory performance of the six-spectrum test, as shown in Table (1). The construction of a neural network show in Fig. (4).

Table 1. **The default settings for parameters after configuring neural for each spectrum**

Parameter Name	Default value
Learning Rate	0.01
Momentum	0.99
Epoch	2000
Hidden layer	3
Iterations	50
Neurons	[12,12,12]
Transfer function	Tansig

Table (2) employs a neural network back propagation arrangement. We have developed a new neural network setup to evaluate the full database simultaneously. A neural network's creation is shown in Fig. (5).

3. EXPERIMENTAL RESULTS

The outcomes of the tests done on the suggested system are displayed in the experiments that follow. The first step of experiment is to test the accuracy of each spectrum separately, then, tested all data together. Table (3) shows the performance parameters of this experiment.

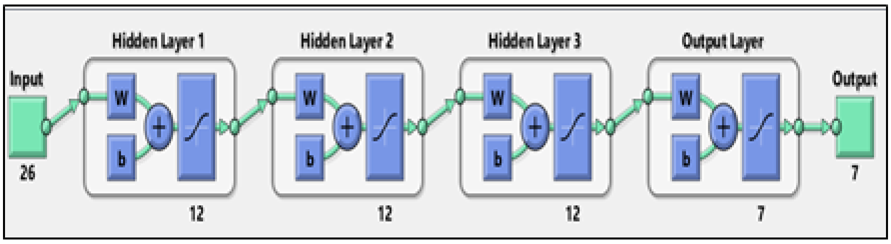

FIGURE 4. Neural Network Topology of each spectrum.

Table 2. The default settings for parameters after configuring neural for all dataset

Parameter Name	Default value
Learning Rate	0.2218
Momentum	0.8275
Epoch	2000
Hidden layer	3
Iterations	50
Neurons	[24,24,24]
Transfer function	Tansig

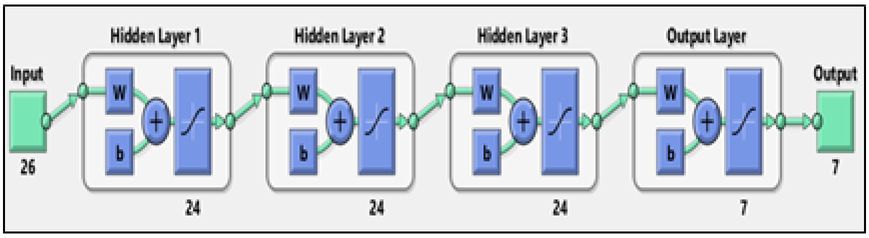

FIGURE 5. Neural Network Topology of all Dataset.

Table 3. The performance parameters for default configuration

Spectrum Name	Batch size	Accuracy (%)	Time (sec)
460	1200	97.59	0.0.02
630	1200	98	0.0.01
700	1200	97.70	0.0.03
850	1200	97.25	0.0.02
940	1200	97.85	0.0.01
WHT	1200	98.25	0.0.02
All Data	1200x6	98.30	0.0.10

4. CONCLUSIONS

The previously proposed features have been tested in this work based on back- propagation neural network and good results are obtained. When all samples were tested, a recognition rate about 98.30%. The possibility of adopting this approach when entering a very large number of persons, as it reduces the time required for the recognition process.

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CONFLICTS OF INTEREST

The author declares no conflict of interest.

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