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# HUMAN AUTHENTICATIONBASED ON HAND SILHOUETTES

**Joy Mercy Mary.G**
Research Scholar, Department of Information Technology, Bharath Institute of Higher Education and Research, Bharath University Chennai, Tamilnadu, India
Email: joyrobbinsqa@gmail.com

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**Abstract**

Human Verification Based on Hand Silhouettes (HVBHS) Algorithm is used for recognizing people with high accuracy, is based on the images of the hands of the subject. The images are captured by a flat bed scanner in an unconstrained pose at 45 dpi. During hand registration the user doesn’t assume or force to keep their hands to any particular orientation, the only assumption is that the fingers are not touching each other. The orientation information of the hand is automatically recovered from the scanned image and then the hand is normalized. The normalization of the hand images involves the reorientation of fingers individually along the standardize directions, without causing any shape distortions. Here hand recognition is based on distance measure between the contours representing the hands, and hence it is shape based. In order to compare different hand geometries the Hausdorff distance method is used.

**Keywords:** Hand registration; Hausdrorff distance; Independent component analysis.

## 1. Introduction

The objective of this project is to implement a global hand shape-based approach for person identification and verification [1]. The algorithm is pivoted on the normalization of the deformable hand shape. In other words, “hand shape normalization” involves the registration of fingers by separate rotations to standard orientations as well as the rotation and translation of the whole hand. Subsequently, person identification is based on the comparison of the hand silhouette shapes using Hausdorff distance or on the distance of feature vectors, namely the independent component analysis (ICA) features [2].

**1.1 Hand Recognition:** Hand geometry recognition is the longest implemented biometric type, debuting in the market in the late 1980s. The systems are widely implemented for their ease of use, public acceptance, and integration capabilities.

One of the shortcomings of the hand geometry characteristic is that it is nothighlyunique, limiting the applications of the hand geometry system to verification[3] tasks only. The system is based on the images of the hands of the subjects, captured by a flatbed scanner in an unconstrained pose at 45 dpi. The user should not force their hand to a particular orientation. The only assumption is that the fingers are not touching. Hand geometry systems use flatbed scanner to capture a silhouette image of the hand (Fig1.2). The hand of the subject is placed on the flatbed scanner, palm down or up. The image captures both the top surface of the hand and the bottom of the hands are analyzed by taking the measurements range from the length of the fingers, to the distance between knuckles, to the height or thickness of the hand and fingers (Fig1.3). This information is stored in nine bytes of data, an extremely low compared to the storage needs of other biometric systems.

Fig 1.1: Bottom View. Fig 1.2: Silhouette of Hand Image Fig1.3: Top View

In order to compare different hand geometrics the hausdroff distance method [4] is used. Hausdorff distance is the maximum distance of a set to the nearest point in the other set. More formally, Hausdorff distance from set A to set B is a maximum function, defined as $h(A,B) = \max_{a \in A} \{ \min_{b \in B} \{ d(a,b) \} \}$ (eq. 1) where a and b are points of sets A and B respectively, and d (a, b) is any metric between these points; for simplicity, take d (a, b) as the Euclidian distance between a and b.Hand geometry recognition systems are widely used for applications in physical access, attendance tracking, and personal verification. They have found a sustainable market in security and accountability applications [6]. Their ease of use, stand-alone capabilities, and small data requirements make them a popular choice for those in need of verification systems.

**1.2 Data collection and feature extraction**

In a preprocessing stage of the algorithm, the hand registration in that it does not assume or force the user to any particular orientation, the only assumption is the fingers are not touching. However collected data using a document scanner, thus no special set up was required. Also the users were free to keep their hands anywhere on the scanner. Users were free to stretch their hands to whatever level they felt comfortable. In fact some of the users were encouraged to stretch their hands to different extents for different scans so as to generate difficult data. In HVBHS algorithm around 30 scans of the right and left hand of 15 people with different orientation is obtained for recognition with unconstrained pose and accessories.

**2. HVBHS - Proposed Algorithm**

2 .1 Image acquisitions & alignment

In image acquisition setup is inherently simple and does not employ any special illumination [2] nor does it use any pegs to cause any inconvenience to users [8].for that Flat bed scanner is used to capture hand images The users were only requested to make sure that

(i) Their fingers do not touch each other

(ii) Most of their hand (back side) touches the imaging table.

**Fig 2.1: sample scanned hand shape images.**

**2.2 Extraction of Hand Geometry Features**

The binary image as shown in Fig2.1 is used to compute significant hand geometry features. Two feature sets are used, finger widths (2 widths per finger), palm width, palm length, hand area, and hand length.

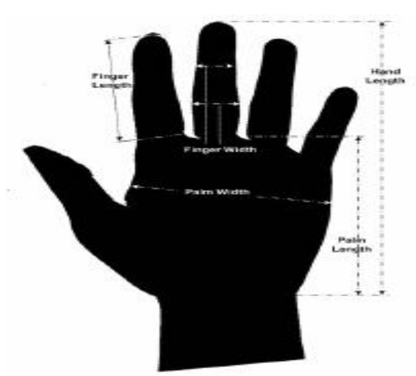


**Fig. 2.2 Hand Geometry Feature Extraction.**

**2.3 Hand Segmentation**

Hand Segmentation extracts the hand region from the background. For that 2 methods of segmentation are used:

A) Clustering followed by morphological operations

B) The watershed transform based segmentation

**2.4 Normalization of Hand Contours**

Normalization of hand images involves the registering of hand images. The registration process involves 2 steps.

1) Translation to the centroid of the hand such that it coincides with the center of the image

2) Rotation toward the direction of the larger eigenvector that is the eigenvector corresponding to the larger eigenvalue of the inertia matrix.

$$\bar{x} = \frac{m_{1\_0}}{m_{0\_0}}$$

$$\bar{y} = \frac{m_{0\_1}}{m_{0\_0}}$$

$$m_{i,j} = \sum_{(x,y)\in object}\sum x^i y^j$$

**2.4.1 Localization of Hand Extremities**

A plot of the radial distance with respect to a reference point around the wrist region is drawn for detecting and localizing the hand extremities (Fig 2.3), that is, the fingertips and the valley between the fingers. This reference point was taken as the larger eigenvector of the inertial matrix with the wrist line. The resulting sequence of radial distances yields minima and maxima corresponding to the sought extremum points.

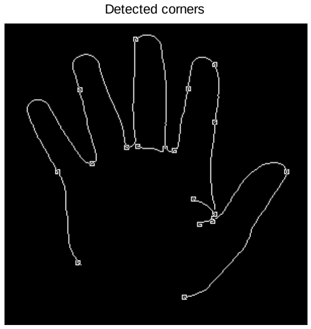


**Fig 2.3 Localization of hand extremities.**

### 2.4.2. Ring Artifact Removal

Presence of an isthmus due to faulty segmentation of a ring (Fig 2.4) can be detected by monitoring the contour distance to the finger's major axis. If the distance exceeds the threshold it is assumed to be the cavity and is repaired by bridging over the cavities with straight lines.

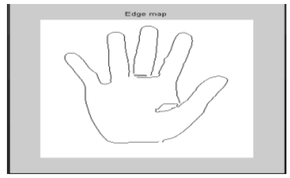

**Fig 2.4 Ring artifact removals.**

### 2.4.3. Finger Registration

Finger registration is done by extending the tip along the finger side toward the two adjacent valley points. The shorter of these two segments is chosen which cuts neatly the fingers. Finger pivots are marked prolonging the major axis of each finger toward the palm by 20% in excess of the finger length (Fig 2.5). A pivot line is created by joining together the pivots of the index and little fingers. Thumb is processed by a rotation followed by a translation.

**Fig 2.5 extraction of middle finger,**

### 2.4.4. Wrist Completion

The irregularities in the wrist region which occur due to Clothing occlusion is solved by connecting the two sides of the palm by a straight line at the latitude of one pivot line length, parallel and below the pivot line.

2.5. Superposition of Fingers: Features consist of hand contour data. Superposition of fingers (Fig 2.6) based on modified Hausdorff distance.

$H(F, G) = \max(h(F, G), h(G, F))$

$F=\{f1, f2, \ldots fNf\}$ and $G=\{g1, g2, \ldots gNg\}$

Nf, and Ng is the numbers of points in sets f & g.

The orientation information of the hand is automatically recovered from the scanned image and then the image is normalized. Normalization involves: reorienting fingers individually along standardized direction there should be no shape distortion.

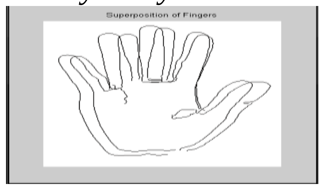


**Fig 2.6 Superposition of fingers.**

**2.6. Feature Extraction & Recognition**

In order to compare different hand geometrics the hausdroff distance method is used. Hausdroff distance method is used in binary images for shape comparison. Features consist of Independent components of the hand Silhouette. Classifier based on the Euclidean distance [10] and Classifier based on modified Hausdorff distance is used.

**3. Result Analysis**

The Human Verification Based on Hand Silhouettes (HVBHS) Algorithm is tested on different types of hands with different orientation such as bare hands, hands with ring, hands with nails and hands with henna tattoos. Each hand image is tested 30 times by the algorithm for calculating the parameters like false rejection rate, false acceptance rate to determine our HVBHS Algorithm's Efficiency. The results are tabulated in the Table 3.1 and shown in the Fig3.1, Fig3.2, and Fig 3.3 given below.

**3.1. Performance Analysis**

**3.1.1 False Acceptance Rate (FAR)**

The percentage of times a system produces a false accept, which occurs when an individual is incorrectly matched to another individual's existing biometric.

**3.1.2 Verification Rate (VR):** The rate at which legitimate end-users are correctly verified. On the basis of above two parameters the query images are tested and tabulated.

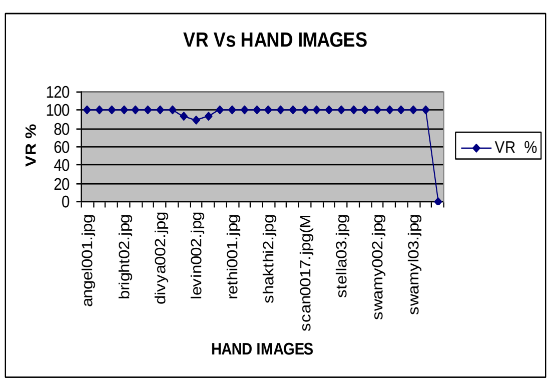


**Fig 3.1 VR Vs Hand Images.**

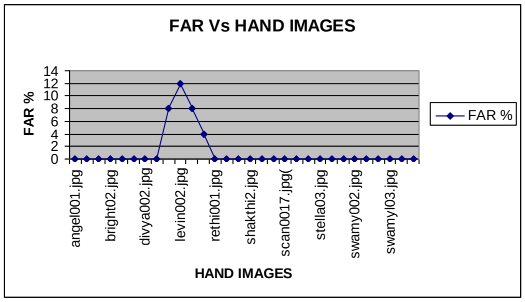


**Fig 3.2 FAR & Hand Images.**

**Table 3.1 Far & Vr Vs Hand Images.**

| **Sl.No** | Query Hand | No. Of Test Run | VR | FAR | VR % |
|---|---|---|---|---|---|
| 1 | angel001.jpg (diff orientation) | 30 | 30 | 0 | 100 |
| 2 | bright002.jpg (diff orientation) | 30 | 30 | 0 | 100 |
| 3 | divya.jpg | 30 | 30 | 0 | 100 |
| 4 | levin001.jpg | 30 | 28 | 2 | 93.3 |
| 5 | levin002.jpg | 30 | 27 | 3 | 90 |
| 6 | rethi001.jpg | 30 | 28 | 2 | 93.3 |
| 7 | shakthi2.jpg (henna tattoos) | 30 | 30 | 1 | 100 |
| 8 | scan0017.jpg (with nails) | 30 | 30 | 0 | 100 |
| 9 | stella03.jpg (RING) | 30 | 30 | 0 | 100 |
| 10 | swamy002.jpg (INVERTED) | 30 | 0 | 0 | 0 |
| 11 | swamy003.jpg | 30 | 30 | 0 | 100 |

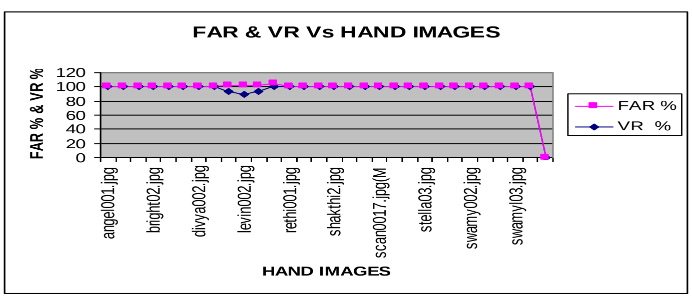


**Fig 3.3 FAR & VR Vs Hand Images.**

## 4. Conclusion and Future Enhancement

Human Authentication Based on Hand Silhouettes can be a viable scheme for recognizing people, with high accuracy. And it can be attractive due to its Unobtrusiveness, low cost, easy interface and low data storage requirement. For any hand base recognition, it is very important, however that the hand image be preprocessed for normalization. Two feature sets have been comparatively assessed by using hausdorff distance methods, for that classification and verification performance are found to be very satisfactory future structuring the system and testing under real life conditions can prove more severely the possibility of hand based access scheme, including the execution time for preprocessing and comparisons.

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