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Multi-Modal Feature Extraction Scheme for Hand Surface Verification Systems

[1] **R.Sumangali** *, [2] **B.Srinivasan** [3] **P.Narendran**
[1] Department of Information Technology
Gobi Arts & Science College, Gobichettipalayam-638453
Email: sumangali.gasc@gmail.com
[2 & 3] Department of Computer Science
Gobi Arts & Science College,Gobichettipalayam-638453

ABSTRACT
In computer security, biometrics specifies to validation schemes that rely on considerable substantial characteristics that can be routinely checked. It is utilized in security and admits control applications to indicate scientific physical characteristics and behaviors of a person that could be checked on a mechanized basis. Several techniques are used for improving the characteristics of each biometric scheme in a different way with different approaches and obtained the various results with some effects. The author Vivek kanhanhad et. Al., presented a 3-D digitizer technique [1] for hand matching that attains considerably enhanced performance still in the existence of large hand pose variations. Nevertheless, these schemes are only able to present low to middle series of security characteristic. Thus, for advanced security trait, the mixture of two or more unimodal biometrics (multiple modalities) is requisite. In this paper, we propose a multimodal biometric system for person recognition using hand images and by integrating four different modalities palmprint, Finger print, Hand geometry and Finger Knuckle-Print (FKP). Addressing this problem, in this work, we are going to develop a feature extraction scheme in which various features of the hand surface such as palm print, finger print, finger knuckles and hand geometry are extracted from the hand surface with different positions. Each feature is initially extracted with geometric dimensions such as size, length, height, and depth of the hand surface. Then micro level features of the hand images such as intensity, and texture are extracted to get the ridges and turfs of the palm, finger and knuckle prints. An experimental evaluation is made with real set of hand images and also synthetic hand image from research repositories with different positions to examine the performance of our proposal work and compared with existing works.
Keywords: *Security, Biometric security, biometric schemes, hand surface, Feature extraction*

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INTRODUCTION

Hand based biometric systems, particularly hand/finger geometry supported substantiation systems are amid the maximum in terms of user suitability for biometric traits. This is obvious from their extensive profitable deployments about the world. In spite of the commercial success, several crises stay behind to be addressed so as to build these systems more accessible. Main troubles comprise, difficulty caused by the controlled imaging set up, particularly to aged and people afflicting from restricted deftness, and hygienic distress with users owing to the assignment of the hand on the imaging podium. Furthermore, shape features (hand/finger geometry or silhouette) hauled out from the hand carry restricted prejudiced information and, as a result, are not recognized to be highly characteristic.

Fundamentally, hand recognition approaches obtainable in the prose can be classified in to three groups based upon the temperament of image acquirement.

1) *Constrained and contact based*: These schemes utilize pegs or pins to restrain the location and attitude of hand. Greater part of profitable systems and untimely research schemes fall beneath this category.

2) *Unconstrained and contact based*: Hand images are obtained in an unimpeded method, often entailing the users to put their hand on horizontal surface or a digital scanner.

3) *Unconstrained and contact-free*: This approach performs gone with the requirement for any hooks or podium through hand image attainment. This form of image attainment is supposed to be more user-friendly and have newly established amplified concentration from biometric researchers.

Congregation of some biometric information, like fingerprints, is regularly connected with illegal behavior. A defeat of privacy or individual dignity happened particularly when the information is

assembled by great institutions for instance the military or police. A computerized *facial recognition* that is employed in open places could be utilized to follow the movements with no knowledge or authority.
There are numerous types of biometric identification schemes are used:

- **face**: facial uniqueness are examined
- **fingerprint**: individual's exclusive fingerprints are examined
- **hand geometry**: shape of the hand and the duration of the fingers are examined
- **retina**: tube vessels situated at the back of the eye are examined
- **iris**: decorated ring that environs the eye's pupil are examined
- **Signature**: the examination of the mode a person signs his name.
- **vein**: the study of prototype of veins in the rear if the hand and the wrist
- **Voice**: the study of the pitch, tone, cadence and occurrence of a person's voice.

Although the field is silent in its infancy, several people consider that biometrics will participate a serious role in prospect computers, and particularly in electronic commerce. Personal computers of the prospect might comprise a fingerprint scanner where a person could situate an index finger. The computer would examine your fingerprint to conclude who the individual are and, supported on the individuality, approve the diverse levels of access. Access levels could comprise the capability to use credit card information to formulate electronic purchases.

An important trait of geometry based technique is the supposition that a person's hand does not radically modify after a confident age. Most of the existing systems utilize more number of qualities to portray a hand. Out of which, finger width might faintly differ over time. Counting such attributes in the procedure of distance metric will particularly diminish the accurateness of the system through practical completion. A simple and easy palmprint biometric security systems has a serious part, for accessing the palmprint, a feature identification method, for palmprint representation, and a matching part for decision making. A FKP-based biometric identification is more current biometric expertise and it has provided an increasing amount of processes. The image-pattern identification of a finger-knuckle has information that has an ability of pro the identity of an individual. The FKP biometric recognizes a person based on the knuckle lines and the textures in the outer finger surface. An important issue in FKP identification is to extract FKP features that can discriminate an individual from the other.

In this work, we are going to develop a feature extraction scheme in which various features of the hand surface such as palm print, finger print, finger knuckles and hand geometry are extracted from the hand surface with different positions. Each feature is initially extracted with geometric dimensions such as size, length, height, and depth of the hand surface. Then micro level features of the hand images such as intensity, and texture are extracted to get the ridges and turfs of the palm, finger and knuckle prints.

LITERATURE REVIEW

Security biometric is the information of utilizing considerable uniqueness (fingerprints, hands, eyes) to distinguish a person and some of the supplies engaged in this scheme include fingerprint person who reads and retinal scanners. When you are permitting for security biometric, you need to contain substantial characteristics that are steady and do not regulate added time and are also compound to imitation or change on purpose. There is a variety of polite trepidation that has been lifted over the service of safety biometric. Some biometric *t*echniques, such as retina scans, are intrusive. Congregation of some biometric in sequence, like fingerprints, is frequently associated with prohibited activities. The paper [1] presents a new approach for hand matching that attains considerably enhanced performance even in the occurrence of huge hand pose variations.

The study in [2] centers on mounting proficient person recognition and identification scheme using hand based biometrics for protected access control. In most of the preceding works on hand-based identification methods, frequently, the significance was not specified to the apex side of the hand, which is exercised in this representation. Also, in some of the previous works, the palm face of the hand was utilized for identification principle. Biometric system has been vigorously rising in diverse industries for the precedent little years, and it is ongoing to roll to present senior security features for access manage system [3]. Many varieties of unimodal biometric techniques have been urbanized. However, these schemes are only proficient to present low to central point variety of security characteristic.

Unimodal biometric systems execute person detection based on a distinct source of biometric in sequence. Such systems are frequently exaggerated by some troubles such as noisy sensor data and non-universality [4]. Consequently, owing to these sensible problems, the error rates connected with unimodal biometric systems are pretty lofty. Some of the troubles that involve unimodal biometric systems can be improved by employing multimodal biometric systems. Hand-based person recognition presents a consistent, low-cost and user-friendly feasible solution for a variety of access control applications [5].

A simple palmprint biometric scheme has a sensor unit, for obtaining the palmprint, a feature taking out module, for palmprint symbol, and a corresponding unit for decision making [6]. An ideal palmprint appreciation system should be supported on the synthesis of several palmprint illustrations [7]. A FKP-based biometric identification is more current biometric expertise and it has involved an mounting amount of concentration. The image-pattern configuration of a finger-knuckle surrounds information that is able of recognizing the individuality of an individual. The FKP biometric distinguishes a person supported on the knuckle lines and the textures in the external finger surface. These line constructions and finger textures are steady and stay behind unaffected during the existence of an individual [8]. An imperative subject in FKP recognition is to remove FKP features that can distinguish a character from the other.

In fact, in distinguish to other modalities like face and iris, the human hand encloses a broad range of modalities, which are hand geometry, fingerprint, palmprint and Finger-Knuckle-Print (FKP). These modalities can be employed by biometric schemes as of some compensations that the biometry of human hand presents [9]. First, data attainment is comparatively simple and inexpensive via profitable low-resolution cameras. Second, hand-based access systems are very suitable for indoor and outdoor usage, and can work well in extreme weather and illumination conditions [10]. Third, hand features of adults are more stable over time and they are not susceptible to major changes [11]. Finally, human hand-based biometric information is very reliable and it can be successfully used for recognizing people among several populations [12]. In this work, we are going to present a multi-modal feature extraction scheme for hand surface verification systems.

PROPOSED MULTI-MODAL FEATURE EXTRACTION FRAMEWORK

The proposed multi-modal feature extarction scheme is efficiently designed for extarcting the micro level features from the set of hand images taken in different positions. After extracting the set of features, the verification of the distinct hand pose is identified through the matching fusion level. The hand geometry images can be extracted from a hand image in a distinct top outlook image of the hand detained from the top glowed camera. The proposed multi-modal feature extraction scheme for hand surface verification systems for person substantiation is done by adapting the various features of the hand surface such as palm print, finger print, finger knuckles and hand geometry that are concurrently obtained from a single hand image. The proposed multi-modal feature extraction scheme for hand surface verification systems is shown in fig 3.1. The steps involved in the proposed multi-modal feature extraction scheme for hand surface verification systems are as follows,

- Image preparation
- Image preprocessing
- Hand geometrical feature extraction
- Knuckle print extraction
- Palm print feature extraction
- Verification

In this paper, we propose a multi-modal biometric system, which extracts the features of the hand surface such as palm print, finger print, finger knuckles and hand geometry for recognition. The following section discusses the automatic tracking algorithm to detect and to extract knuckle print and palm print for recognition.

Image Preparation

Initially the hand images are obtained from the chosen user group and stored in the database. For that reason, we used normal digital camera which is escalated in a unique collection. Through the time of registering the users and organizing the dataset, the users are requested to put the hand as much as probable on a distinct guide line strained on the black surface. The Guideline was exercised only to put the middle finger of the hand. The hand images of the similar person were taken in diverse positions in different time intervals.

Image preprocessing

In this stage, the input hand image is preprocessed with the purpose of regulate the disparity and intensity of input image. Then, middle filter is exercised to eliminate the "Salt and Pepper" form noises from the preprocessed image. It decreases the shadowing of edges. Further, some unnecessary segments of the unusual images were yielded mechanically, ensuing in obvious hand images of consistent size. The images were then leveled down to an appropriate size, lesser than the unique size for managing them with improved performance in terms of speed.

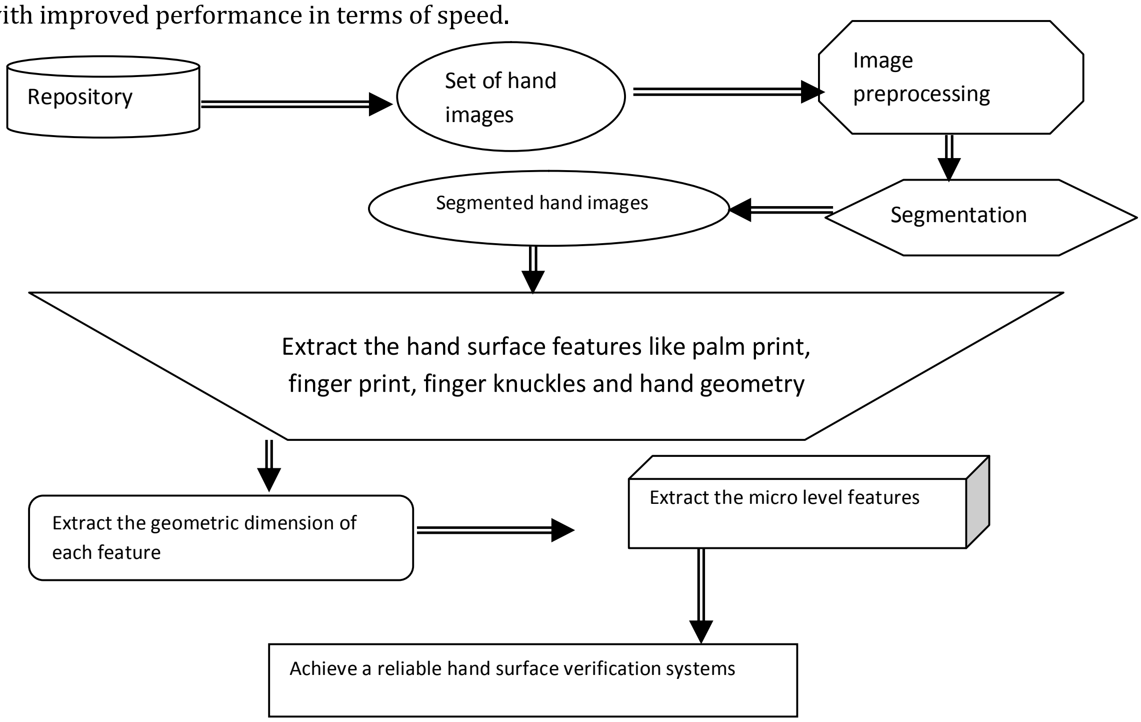


Fig 3.1 Architecture diagram of the proposed MFEHS

Extracting Palm Print Feature

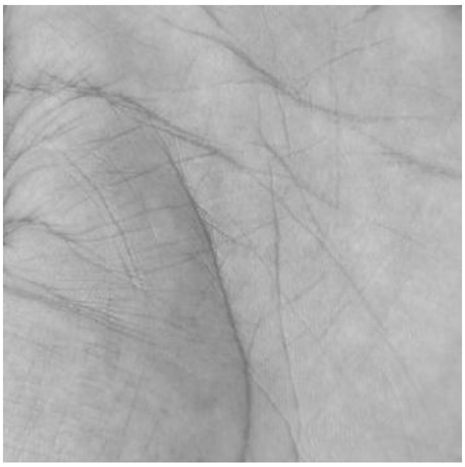
Although the lines presents on palm and knuckle prints are identical, we cannot employ the similar process for the reason that knuckle print has simpler and horizontal-like line patterns. Consequently, edge-sensitive process, for instance, ridgelet transform would be more appropriate. Additionally, palm print has some crossed line patterns from diverse directions and therefore some other solution is needed to obtain palm print features.

Each of these features is used to strain $I'(x,y)$ as follows:

$$I_1(x,y) = h_1 * I'(x,y) \text{ ..... eqn 1}$$

Where '*' indicates the distinct 2D complication. Thus four filtered images, *i.e.*, $I_1(x,y), I_2(x,y), I_3(x,y)$ are used to produce a final image

$I_f(x,y)$ *by* $I_f(x,y) = \max\{ I_1(x,y), I_2(x,y), I_3(x,y) \}$...... eqn 2



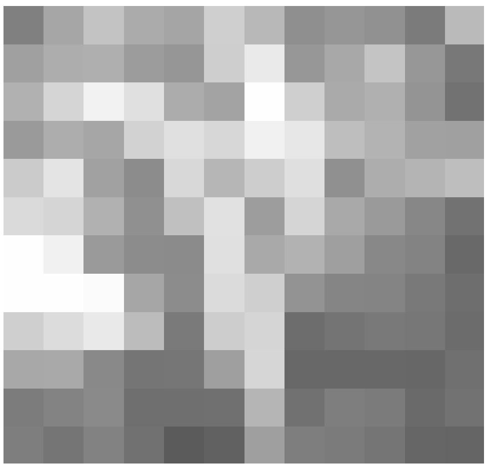


Fig 3.2 a) Input image b) Feature extracted from palmprint

The consequential image symbolizes the mutual directional map of palmprint $I(x,y)$. This image $I_f(x,y)$ *is* exemplified by a position of restricted features, *i.e.*, typical deviation, and employed for confirmation. I_f(*x*,

y) is divided into a position n blocks and the typical difference of gray-levels in all of these overlying blocks is used to figure out the feature vector.

$\boldsymbol{v}_{palm} = \{s1, s2, \ldots, sn\}$…….. eqn 3

Where $s1$ is the average deviation in the partly covering first block

Hand Geometrical Feature Extraction

Additionally to that, we addressed a technique for deciding finger length from the image and we suggest the proposal of including/excluding the finger nail length in the calculations of finger length. In the hand geometry based admiration scheme, we formed 14 attributes from the hand and the palm print of the hand image is:

- Finger tip extents from a complete position point
- Valley point extents from the complete orientation point
- Left Middle location position extents from the complete orientation point

Two Bottom orientation point extents from the complete reference point

- Area of the hand image
- boundary of the hand image

Finger lengths are considered from the unlimited orientation point, the extent of valley point are also considered from the supreme orientation point. The area of the hand image and boundary of the hand image are considered in pixels. Consequently, the hand geometry of every hand image is exemplified by a feature vector of lengths, circumferences and area. In this proposed implementation, in addition to that 14 hand attributes we used some distinct set of attributed for better accuracy in recognition. They are:

- The lower thickness of the palm
- The focus thickness of the palm
- The boundary of the dorsum of palm
- The general ROI boundary of the hand.
- The thumb joint breadth
- minute finger joint breadth
- Valley to valley extents

Each of the acquired hand geometry featured images needs to be associated in a favored direction so as to detain the similar features for verification systems. The image threshold process is employed to attain a binary hand-shape image. The threshold charge is routinely calculated employing Otsu's method. As the image surroundings is steady (black), the threshold charge can be calculated one time and used consequently for other images. The binarized contour of the hand can be approximated by an ellipse. The constraints of the best-fitting ellipse, for a specified binary hand shape, are computed by means of the moments. The point of reference of the binarized hand image is approximated by the main alignment of the ellipse and the essential angle of rotation is the distinction among standard and the point of reference of image.

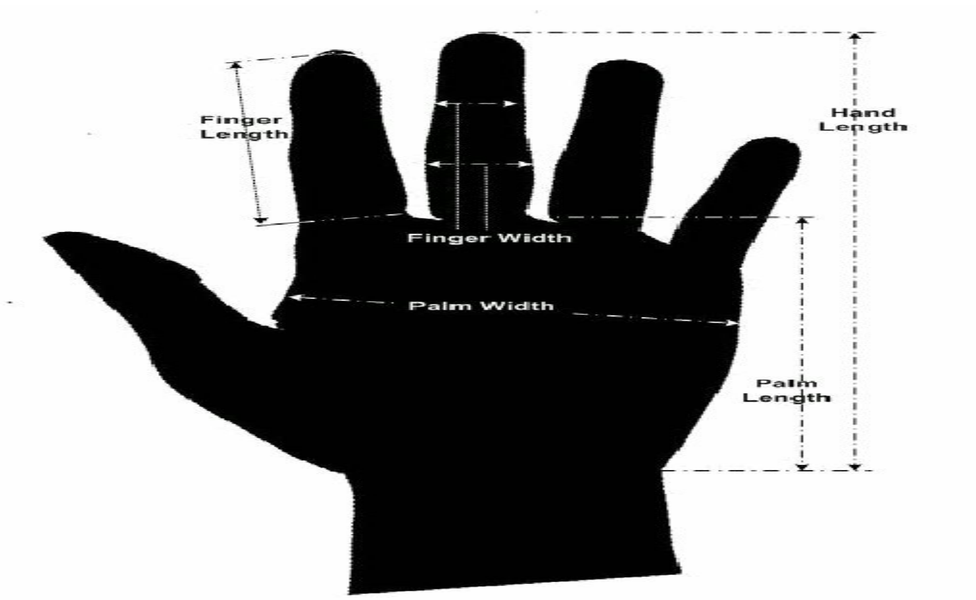


Fig 3.3 Hand geometry feature extraction

The binary image for hand geometry feature extraction is employed to calculate considerable hand geometry features. A hand geometry features were utilized with finger widths, finger lengths, palm extent, palm breadth, hand extent, and hand region. As a result, the hand geometry of each hand image is processed by a feature vector $\boldsymbol{v}_{hg}$ of duration.

Extracting features of finger knuckle finger print

The proposed FKP feature extraction system is poised with FKP image attainment device and a data proceeding unit. The confined FKP image is given as input to the data processing unit, for feature extraction and it is shown in fig 3.3.

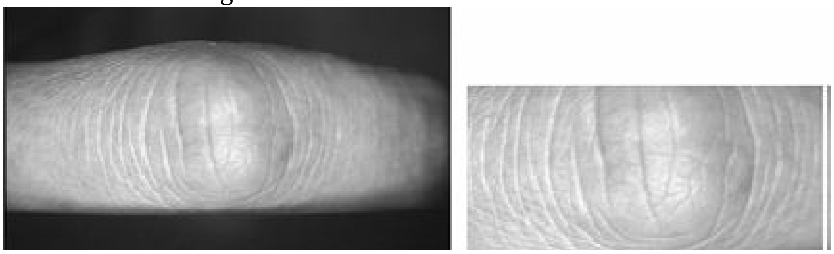


Fig 3.4 a) Input image b) is the feature extracted image

It is essential to create a local coordinate scheme for every FKP image. With such an organized scheme, an ROI can be yielded from the unique image for consistent feature drawing out. The detailed steps given below describes a coordinate system are as follows.

Step 1: establish the *X*-axis of the management scheme. The bottom frontier of the finger can be simply hauled out by an edge detector. Really, this bottom frontier is almost dependable to all FKP images since all the fingers are set completely on the basal block in data attainment. By correcting this boundary as a instantly line, the *X*-axis of the confined coordinate system is dogged.

Step 2: pick a sub-image I_S. The left and right limitations of I_S are two predetermined values assessed empirically. The top and bottom limitations are projected consistent with the frontier of genuine fingers and they can be attained by an edge detector.

Step 3: Canny edge detection. Concern the Canny edge detector to I_S to attain the edge chart I_E.

Step 4: convex way system for I_E. We describe a model for FKP "curves". In this representation, an FKP "curve" is moreover convex leftward or convex rightward. We cipher the pixels on curved leftward as "1", pixels on curved rightward as "-1", and set other pixels not on some curves as "0".

Step 5: establish the *Y*-axis of the manage scheme. For an FKP image, "curves" on the left division of phalangeal mutual are habitually curved leftward and those on the right part are typically curved rightward. In the meantime, "curves" in a minute area about the phalangeal joint do not contain palpable curved directions. Based on this surveillance, at a level location *x* (*x* represents the column) of an FKP image, we characterize the "convexity magnitude" as:

$$con - Mag(x) = abs\left(\sum_{W} I_{CD}\right) \quad \text{....... Eqn 4}$$

Where *W* is a window being balanced about the axis *X* = *x*. *W* is of the size *d*×*h*, where *h* is the height of I_S. The feature of the FKP image proposes that *con-Mag*(*x*) will attain a smallest amount about the center of the phalangeal joint and this location can be employed to locate the *Y*-axis of the synchronized system.

Step 6: crop the ROI image. Currently that we have set the *X*-axis and *Y*-axis, the local synchronized system can then be dogged and the ROI sub-image I_{ROI} can be hauled out with a preset size. By following the above six steps, we extract the features of the knuckle print from the hand surface.

The procedure below describes the process of the proposed multi-modal feature extraction scheme with an appropriate technique.

Input: Hand surface with different positions

Step 1: Prepare and store the image in the database

Step 2: Based on users' request,

Step 3: Retrive the hand image from the dataset

Step 4: Preprocess the image to eliminate noise

Step 5: Segment the image to extract the features in a less interval time

Step 6: Extract the palmprint image from the dataset

Step 7: With the ridgelet transform, obtain the features of palmprint

Step 8: Store the features in a separate database

Step 9: Extarct the hand geometry image from the database

Step 10: With the feature vector, obtain the features of hand geometry pose variations

Step 11: Obtain the features by computing the
Area of the hand image
Boundary of the hand image
Step 12: End
Step 13: With the steps discussed in section 3.4
Step 14: Obtain the features of knuckle print
Step 15: For each feature (F) obtained for palm print, hand geometry, knuckle print
Step 16: Obtain the geometric dimensions like
Size (s) of the hand
Length (l) of the hand and
Depth (d) of the hand
Step 17: End For
Step 18: End
Step 19: Extarct the micro level features
Step 20:Obtain the ridges and turfs of the palm, finger and knuckle prints.
Step 21: End
With the above steps, we processed and extract the features of the hand surface and the evaluation report of the proposed multi-modal feature extraction scheme is discussed in the next section.

EXPERIMENTAL EVALUATION

An experimental evaluation is conducted to estimate the performance of the proposed multi-modal feature extraction scheme for hand surface verification systems. The proposed multi-modal feature extraction scheme is implemented in MATLAB. Finally experimental evaluation is made with real set of hand images and also synthetic hand image from research repositories with different positions to examine the performance of the proposed multi-modal feature extraction scheme for hand surface verification systems and compared with existing works. At first, various features of the hand surface such as palm print, finger print, finger knuckles and hand geometry are extracted from the hand surface with different positions. Each feature is initially extracted with geometric dimensions such as size, length, height, and depth of the hand surface. Then micro level features of the hand images such as intensity and texture are extracted to get the ridges and turfs of the palm, finger and knuckle prints. The performance of the proposed multi-modal feature extraction scheme for hand surface verification systems is evaluated in terms of

i) Number of hand images
ii) Number of features extracted
iii) Geometric Dimensional Ratio
iv) Number of turfs and pores

RESULTS AND DISCUSSION

In this work, we have seen that the proposed multi-modal feature extraction scheme is efficiently desgined for hand surface verification systems. For a diverse set of hand images, the features are extracted at first by following the set of processes like Image preparation, Image preprocessing, Segmentation, Hand geometrical feature extraction, Knuckle print extraction, and matching process. After extracting all set of features, the geometric dimensions such as size, length, height, and depth of the hand surface are also been extracted to get the ridges and turfs of the palm, finger and knuckle prints. The below table and graph describes the performance of the proposed multi-modal feature extraction scheme for hand surface verification systems.

No. of hand images	Number of features extracted		
	Proposed MFEHS	Existing HG	Existing FP
1	8	4	3
2	12	8	5
3	16	9	6
4	17	12	8
5	20	15	11
6	22	14	12

Table 5.1 No. of hand images vs. Number fo features extracted

The above table (table 5.1) describes the extraction of features froma diverse set of hand images. The total number of extraction of features by the proposed multi-modal feature extraction scheme for hand surface verification systems is comapred with an existing hand geometry feature extraction [HG] and Finger print extarction [FP] by different set of schemes.

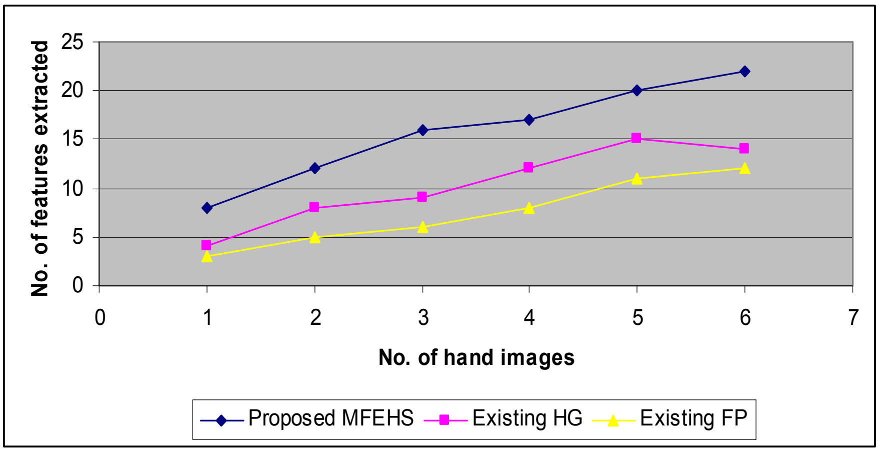


Fig 5.1 No. of hand images vs. Number fo features extracted

Fig 5.1 describes the extraction of features from a diverse set of hand images. Since the proposed MFEHS provides an extraction of features of the hand surface such as palm print, finger print, finger knuckles and hand geometry are extracted from the hand surface with different positions. Based on the position of the hand surface, the extraction of different set of features is done in a less interval of time. The above graph describes the number of features extracted from the differnet set of hand images with different pose variations. Since more set of features are extracted in the proposed multi-modal feature extraction scheme for hand surface verification systems, the propsoed MFEHS is the best method for feature extraction compared to the other existing works like hand geometry feature extraction [HG] and Finger print extarction [FP] by different set of schemes. The variance in the extraction of features from the hand images is 40-50% high in the proposed MFEHS.

No. of features	Geomteric Dimensionality ratio		
	Proposed MFEHS	Existing HG	Existing FP
2	24	10	8
4	29	13	12
6	34	16	16
8	40	18	14
10	46	17	13
12	52	20	18

Table 5.2 No. of features vs. Geometric Dimensionality ratio

The above table (table 5.2) describes the ratio of geometric dimensionality extracted from a diverse set of features extratced from hand images in a different pose variations. The geometric dimensionality of features for different hand images by the proposed multi-modal feature extraction scheme for hand surface verification systems is comapred with an existing hand geometry feature extraction [HG] and Finger print extarction [FP] by different set of schemes.

Fig 5.2 describes the ratio of geometric dimensionality extracted from a diverse set of features extratced from hand images in a different pose variations. The purpose of Geometric Dimensionality is more precisely termed as relating the geometric necessities for part and congregation geometry of the extracted features from the hand images obtained in different hand pose variations. Dimensions should be functioned to features and approved in such a mode as to symbolize the purpose of the features. Compared to the existing hand geometry feature extraction [HG] and Finger print extarction [FP] by different set of schemes, the proposed MFEHS provides an efficient geometric dimension such as size, length, height, and depth of the hand surface. The variance in geometric dimensionality based on different set of features is 30-40% high in the proposed MFEHS.

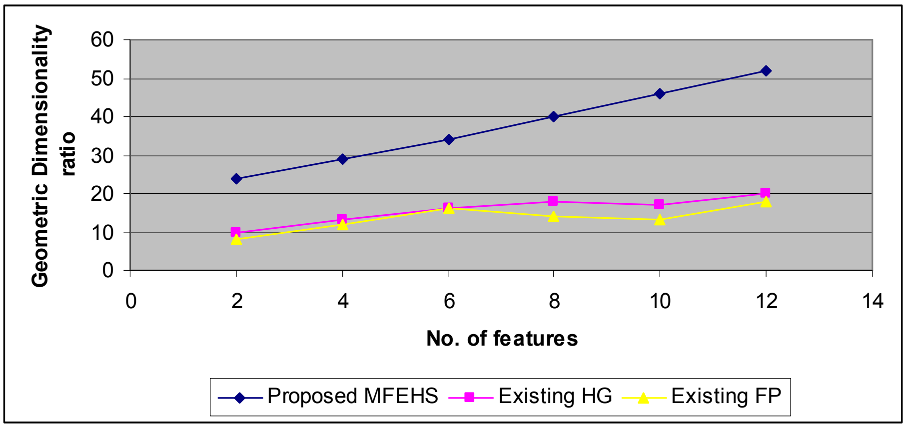


Fig 5.2 No. of features vs. Geometric Dimensionality ratio

No. of features	Number of turfs and pores		
	Proposed MFEHS	Existing HG	Existing FP
2	9	5	4
4	13	7	8
6	15	9	6
8	17	13	12
10	19	11	15
12	22	12	13

Table 5.3 No. of features vs. No. of pores and turfs

The above table (table 5.3) describes the number of pores and ridges extracted from the micro level features of the hand images extratced in a different pose variations. The extarction of pores and turfs features for different hand images by the proposed multi-modal feature extraction scheme for hand surface verification systems is compared with an existing hand geometry feature extraction [HG] and Finger print extarction [FP] by different set of schemes.

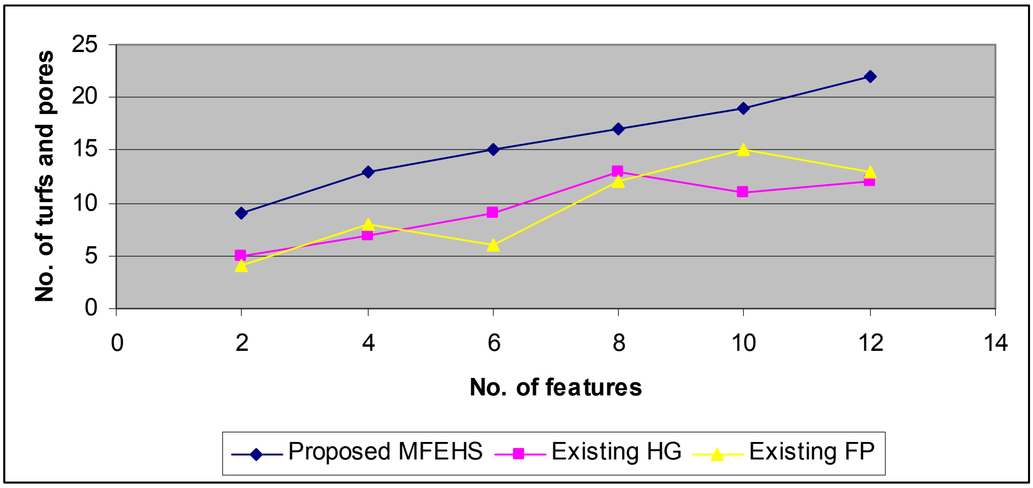


Fig 5.3 No. of features vs. No. of pores and turfs

Fig 5.3 describes the number of pores and ridges extracted from the micro level features of the hand images extratced in a different pose variations. The proposed MFEHS provides a process of extraction of micro-level features from the geometric dimensions of the features already extracted from the diverse set of hand images. Compared to the existing hand geometry feature extraction [HG] and Finger print extarction [FP] by different set of schemes, the proposed MFEHS provides an efficient micro evel feature extraction process such as intensity, and texture to get the ridges and turfs of the palm, finger and knuckle

prints. The variance in micro level feature extraction based on different set of features is 50-60% high in the proposed MFEHS.
Finally it is being observed that the feature extraction scheme is efficiently done for various features of the hand surface such as palm print, finger print, finger knuckles and hand geometry with different positions. Each feature is initially extracted relaibly with geometric dimensions such as size, length, height, and depth of the hand surface. Then micro level features of the hand images such as intensity, and texture are extracted in an efficient manner to get the ridges and turfs of the palm, finger and knuckle prints.

CONCLUSION

The objective of this work was to investigate the integration of multi-modal features of hand surface such as palm print, finger print, finger knuckles and hand geometry, and to achieve higher performance that might not be probable with single biometric pointer alone. The diverse set of features is obtained from the hand images which are in different positions. Each feature from the hand surface is initially extracted efficiently with geometric dimensions such as size, length, height, and depth of the hand surface. Then micro level features are extracted from the hand images such as intensity, and texture to get the ridges and turfs of the palm, finger and knuckle prints. An experimental evaluation is conducted with real and synthetic set of hand images and tthese results should be deduced in the framework of a rather easy image acquirement setup; more development in performance, in the occurrence of restricted illumination/environment, is instinctively estimated. The achieved results are important as the multi-biometric traits were derived from the similar image. Our results also showed that the proposed multi-modal feature extraction for hand surface verification systems provides an efficient feature extraction compared to the other existing works.

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