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Identification of Finger Print Patterns Using a Robust Feature Extraction and Classification Method

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Abstract: **- In recent years, fingerprints are measured to be the finest method for biometric classification. These patterns are secure to use, distinctive for every person and do not change in one's lifetime. Human fingerprints are well-off in information called minutiae, as per the individuality of the fingerprint it provides us methods of flawless detection. This work is based on the pattern type identification using features that are extracted based on minutia and are classified based on the classifiers of Neural Networks. In this paper, the images are preprocessed using thinning, termination, bifurcation, ridge to valley area process that are to obtain the final minutiae. Featured values such as mean and standard deviation are extracted from the preprocessed image. Then the classification process is done to determine which pattern is the inputted fingerprint based on their values. Classification information is essentially concerned with line patterns, whereas individual information is based on a straight or curved continuous ridgeline. The Classification processes are done using the K Nearest Neighbor Classifier using the outputted image obtained from the preprocessing and the feature extraction values. In the classification scheme, arches pattern loops pattern Whorls pattern were identified from the fingerprint images. The fingerprint classification defines the count of the pattern from the collection of images. The experimental result of the study is fully functional on the minutiae-based method and the values for identifying the different patterns.**

Keywords**: Finger Print, Feature Extraction, KNN Classifier, Minutiae, Neural Network, Pattern.**

I. INTRODUCTION

Fingerprints are the inborn feature of mankind. The patterns of fingerprints remain unchanging for one's life time. Fingerprints are physiological traits that can be viewed as texture patterns formed by ridge. The impression of the ridge can be viewed on the surface of various materials and the impression is formed by ink. When digitized they can be used to identify an individual based on peculiar uniqueness of the fingerprint pattern in the programmed manner. This paper deals with the Identification of Fingerprint patterns. Human fingerprints are unique, depth in nature, complicated to modify, and long-lasting over the life of a human being, making them suitable as Continuing markers of human distinctiveness. A fingerprint is a graphical pattern of ridges and valleys on the surface of a human finger. Due to the individuality of the fingerprint for every human provides us with all we need for flawless identification. This project deals with the identification of the patterns which are latent in nature and the patterns are mainly defined by means of minutia. This process deals with the set of images. The minutiae in the finger print provide the detailed structure of the ridge-valley patterns. The minutiae are foremost features of a fingerprint image in biometrics and forensic science which is used for the comparisons of one print with another. Minutiae include:

Ridge ending – The purpose of ridge ending is the point at which a ridge gets terminated.

Ridge bifurcation – Bifurcations are points at which a single ridge splits into two ridges. A fingerprint is the pattern of ridges and valleys on the surface of a fingertip. The cross points and endpoints of ridges are called minutiae. It is a widely accepted statement that the minutiae pattern of each finger is distinctive and does not modified during one's life. Ridge endings are the process where the points in the ridge arc get terminated. The bifurcations are where a ridge splits from a single lane to double lane as s Y-junction. The Fig1.Represents the bifurcation and termination point of the finger print.

Fig.1 Termination and Bifurcation

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Regular fingerprint classification systems use the two basic types of minutiae that exist, being ridge endings and bifurcations. Sometimes combined types of minutiae such as lakes or short ridges are also used. Neural network falls in the discipline of the adaptive systems. In this process the classification is done using classifier of neural network. Neural networks is an interdisciplinary that draws upon the brain metaphor to bring together ideas from neuroscience, mathematics and computer science whose traits are designed to learn from the ecological inputs in order to perform intelligent tasks.

A. FINGER PRINT PATTERNS

Patterns are mainly categorized into three types such as Arch, Loop and Whorl which is represented in the Fig 2.

Fig .2 Classification of patterns

1. Arch: It creates a wave like pattern and includes plain arches and tented arches. The arch pattern contains the orientations of texture around the center are balanced and the orientations of each block are all downward and outward. The ridges enter from one side of the finger, rise in the center forming an arc.

The arch patterns are subdivided into Simple Arch, Tented Arch.

2. Loops: The Loop Patterns are formed by the formation of ridges that enter from one surface of a finger, form a curve, and then exit on that same side.

The loop Patterns are further divided into ulnar loop, radial loop, concentric loop etc..,

3. Whorl: Ridges form circularly around a central point on the finger. The texture orientations of the left and right blocks are even to each other and downward and the orientations of the blocks above the center and that are under the center are outwards and inwards, correspondingly. The subdivided whorl patterns are Spiral whorl, Composite whorl, Peacocks whorl Patterns.

II. LITERATURE REVIEW

Ravi. J, K. B. Raja and Venugopal. K. R [1] proposed the method by pre-processing the original Fingerprint. This process involves image binarization of the image, ridge thinning, and noise removal. Fingerprint Recognition using Minutia Score Matching method is used for matching the minutia points. The minutiae location and the minutiae angles are derived after minutiae extraction. The terminating points that lie in the external boundaries are not measured as minutiae points, and the Crossing Number is used to situate the minutiae points in fingerprint image. Crossing Number is defined as partially of the sum of differences connecting intensity values of two neighboring pixels. The Termination, Ridge and Bifurcation are classified from minutiae points obtaining the crossing number.

Dr. Neeraj Bhargava, PrafullNarooka and,MinaxiCotia [2] presents the types of fingerprint patterns and matching techniques. Fingerprint recognition is one of the most reliable, important and functional biometric technique used for person identification and verification. The Classification of Fingerprint patterns are divided into three main groups consisting of Arches, Loops and Whorls. In this Process they have described the Minutiae based fingerprint recognition consists of Thinning, Minutiae extraction, Minutiae matching and computing matching score.

Mridula and Priyanka [3] studied the various Reviews on Classification of Fingerprint Images. They presented a Syntactic method to represent a fingerprint by the features extracted from the ridge flow or orientation field. This method adopted the fundamental ridge patterns and the analysis of ridge shape and sequence of ridge shapes. Categorization is performed by determining which syntax most likely generates the feature extracted from a query fingerprint.

Ching-Tang Hsieh1, Shys-Rong Shyu1 and Kuo-Ming Hung, [4] described the effective method for the fingerprint classification, which uses both the orientation characteristic and singular points around the center of the region of interest. In the phase of feature extraction, this process finds a center of a similar circle from the orientation field and extracts the features around the middle for the classification and also uses the Poincare index for detecting the region of interest includes any singular points or not.

Ravi Subban and Dattatreya P. Mankame [5] proposed Finger Print identification based on minutiae or location and direction of the ridge endings and bifurcations (splits) along a ridge path. The frequently used FP matching techniques are minutiae-based and pattern matching. Pattern matching just compares two image for checking similarity.

Minutiae matching relies on minutiae points i.e. location and direction of each point. Also the performance analysis was performed in his study to improve the fingerprint classification and identification.

Ritika Dadhwal and Ajmer Singh [6] Proposed ‘comparison between feature extraction techniques for fingerprint based gender classification using K Nearest Neighbor (knn) classifier’. In this approach the Knn is used to classify the gender based on the finger print. This techniques process some feature extraction methods and finally the

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Classification process is based on the classifier. The knn classifier processed based on the Euclidean distance value.
Alaa Ahmed Abbood and Ghazali Sulong [7] proposed the difficulties and the trouble that are associated with large intra-class variation. In this process the prints of the same class have the same similarity characteristics. In this paper it was described mainly about the two features, global feature and the local feature. The inclusive feature obtained by the fingerprint image is described by the structure shape such as ridge and valleys and the singular points. The local feature of the fingerprint contains the minute information of the ridges. The global feature has the overall details which are considered as the valid feature used in the design of automatic fingerprint identification system.

III. METHODOLOGY

Fingerprint Pattern identification using Minutia-Based is processed for matching the minutia. A Fingerprint can be identified by its special features such as ridge endings, ridge bifurcation. These ridge features are collectively called minutiae of the fingerprint.

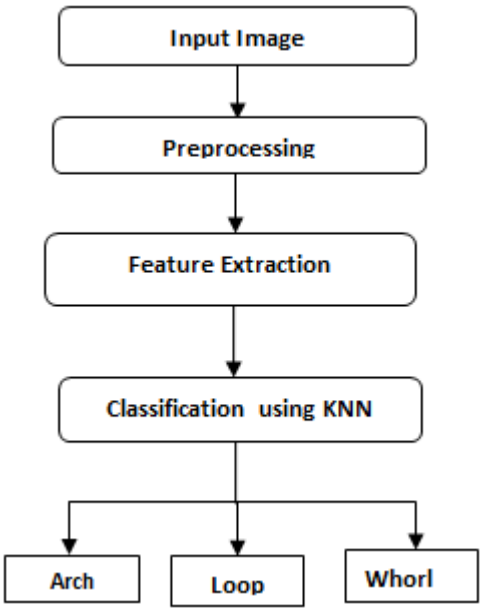

Fig.3 Process of the pattern identification

The Fig.3 represents the step by step process of the pattern identification. The minutiae position and the minutiae angles are resulted after minutiae extraction. The process involves preprocessing using binarize, thinning, termination, bifurcation and ridge to valley area are used to obtain final minutiae based on the preprocessing. Then the features are extracted from the resulted images. Finally the patterns are identified based on the KNN Classifier.

A. PREPROCESSING:

The pre-processing of the original fingerprint involves image binarization, ridge thinning, Termination and Bifurcation and ridge to valley area. The Steps involved in the preprocessing that are used for extracting minutiae are,

1. **Read the Input image.**
2. Binarize the Image: Binarization converts a grey level image into a binary image to improve the contrast between the ridges and valleys in a fingerprint image which leads in the extraction of minutiae.
3. Thinning the image: Thinning the image is the process of decrease the thickness of all ridges lines into single pixel width. Thinning is the process that are used to remove the additional pixel of ridges till the ridges became one pixel broad. It is processed by the inbuilt morphological thinning function “bwmorph”.
4. Termination: The location where a ridge comes to an end. It defines the path from which the ridge starts and ends. The method called region props are used to obtain the ridge ending.
5. Bifurcation: The bifurcation is a point in a finger image at which two ridges meet. It indicates the location where a ridge divides into two separate ridges. In the bifurcations the appearance will be between the branch points which are present on the curved lines.

The Fig.4 shows the image after the termination and bifurcation process.

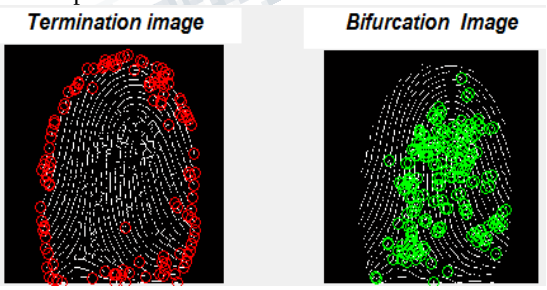

Fig. 4 Image after Termination and Bifurcation

6. Ridge to valley area: The finger print image is bounded in a bounded box in confine the finger prints in a closed circumference. Excess area is removed or not considered in calculation. Ridges are defined as the black impression in the finger print images while valley is that of white portion in the same. The final minutiae is obtained by the bifurcation and termination processed on the base of ridge to valley area method.

B. FEATURE EXTRACTION

The Feature Extraction for finding the fingerprint features is based on the mean and Standard Deviation values. The Mean and Standard deviation values of the one pattern differ from the other.

1. Mean: Mean is a featured value that are calculated from the preprocessed image and are used for the classification of the patterns in the finger print. The Mean is calculated by the method mean2().
Where,
Mean = mean2 (I); where I – image

2. Standard Deviation: Standard deviation(s) is measures the variability about the mean of a data. The mean of the elements of A along the first array dimension whose size does not equal 1.Its is obtained from the method std2(). Where,
Standard=std2 (I); where I - image

C. CLASSIFICATION:

The Classification processes are done using the K Nearest Neighbor (KNN) Classifier using the outputted image obtained from the preprocessing and the Feature extraction method. The classification does not attempt to build a general internal model, but simply stores instances of training data. Classification is computed from a simple majority classes to make your choice of the nearest neighbors of each point: a query point is assigned the data class which has the majority representatives within the nearest neighbors of the point. The Classification is done to obtain the category of the pattern of the finger print as arch, loop and whorl based on the featured values obtained from the final minutiae. The Classification is based on the matching of the training values. The patterns are classified by Class = knn classify(Sample, Training, Group) enables specify the number of nearest neighbors used in the classification.

1. Sample: The process in which the matrix whose rows will be classified into groups. Sample must have the identical number of columns as Training.
2. Training: In this process the matrix is used to group the rows in the matrix sample. Training must have the same number of columns for Training. Each row in the Training section belongs to the group whose value is the corresponding entry of group.
3. Group: In this process the vector whose distinctive values classify the grouping of the rows in Training.

IV. EXPERIMENTAL RESULT

The performance of a fingerprint categorization system is frequently measured in terms of classification. In this study, the collections of 60 images are taken as sample data. The Images get preprocessed using binarization, thinning, termination, bifurcation and ridge to valley area to obtain the final minutiae. The features like mean and standard deviation values are extracted and for the classification the values of final minutiae is taken as the input and it gets classified using KNN as per the trained image values.
The sample data of the trained images are tabulated in the Table I.

Table I Training data for classification

Images	Mean	Standard Deviation	Type
A1	0.0382	0.1917	ARCH
A2	0.0382	0.1917	ARCH
A3	0.0613	0.2398	ARCH
A4	0.0671	0.2502	ARCH
A5	0.0985	0.2980	ARCH
A6	0.0592	0.2359	ARCH
L1	0.0417	0.1998	LOOP
L2	0.0445	0.2062	LOOP
L3	0.0474	0.2126	LOOP
L4	0.0683	0.2522	LOOP
L5	0.0676	0.2510	LOOP
L6	0.0553	0.2285	WHORL
W1	0.0460	0.2094	WHORL
W2	0.0495	0.2169	WHORL
W3	0.0378	0.1907	WHORL
W4	0.0526	0.2232	WHORL
W5	0.0301	0.1709	WHORL
W6	0.0228	0.1494	WHORL

The classified images are grouped into patterns such as arch, loop and whorl using the KNN classifier. Among the 60 images 21 are classified as arch, 17 are classified as loop and 22 are classified as whorl. Here, the loop patterns are less classified. The classification results of the images are tabulated in the Table II.

Table II Fingerprint Classification

S. No	Pattern Type	No. of images
1	Arch	21
2	Loop	17
3	Whorl	22
Total		60

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Finger print patterns are divided into three main groups. They are Arch, Loop and Whorl. These patterns are categorized by using the mean and standard deviation value taken as the sample and training data's. The Fig 5, 6, 7 shows the experimental result of the arch, loop and whorl patterns.

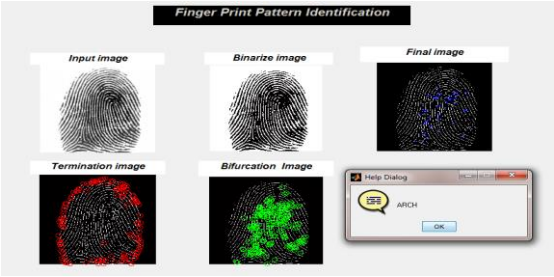

Fig.5 Arch Pattern

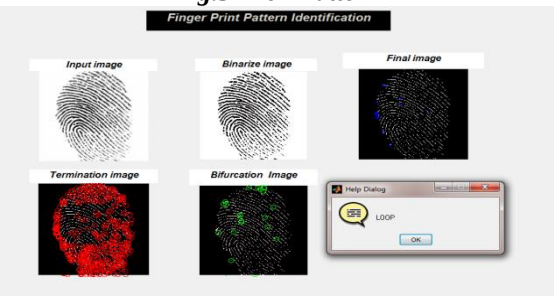

Fig.6 Loop Pattern

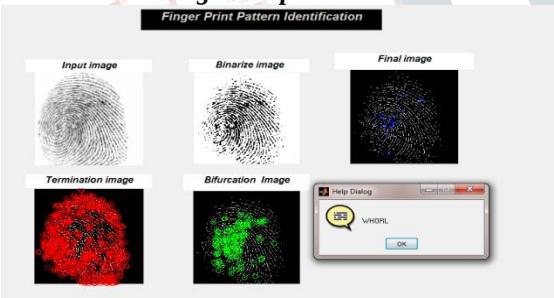

Fig. 7 Whorl Pattern

V. CONCLUSION

This proposed work used the preprocessing of fingerprint images, such as binarization, thinning, bifurcation, termination and ridge to valley area. Then the feature extraction is obtained using the mean and standard deviation. These featured values are applied for classification. Finally identification of the fingerprint Patterns is done using KNN classifier. The output is based on the feature extraction values which are different for a particular class. The patterns are classified into three classes such as Arch, Loop and whorl. Number of experiments was conducted and very promising results are obtained from the collection of fingerprint images. From the classification of the patterns the arch are around 21 and loop are 17 and Whorls are 22 from the given set of images. The future work will incorporate the fingerprint identification technique based on fuzzy logic for identification process.

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