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A Survey on Fingerprint Identification Techniques

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Abstract: ***Quality fingerprint images are very important in materializing a fool proof fingerprint recognition system. Fingerprint can be of poor quality due to various factors such as skin ailments, scars and other medical reasons. This paper presents a common survey on latest advances on fingerprint matching and classification techniques. Fuzzy Neural networks use modern techniques that given more accurate results in establishing the identity through fingerprint.***
Keywords: Computer Vision, Finger Print, Image Acquisition, Pre-Processing, Feature Extraction, Matching techniques, Spatial methods, Transform Methods, Histogram Modelling, Haar Wavelet, Graph Models, Fuzzy Neural Network.

I. INTRODUCTION

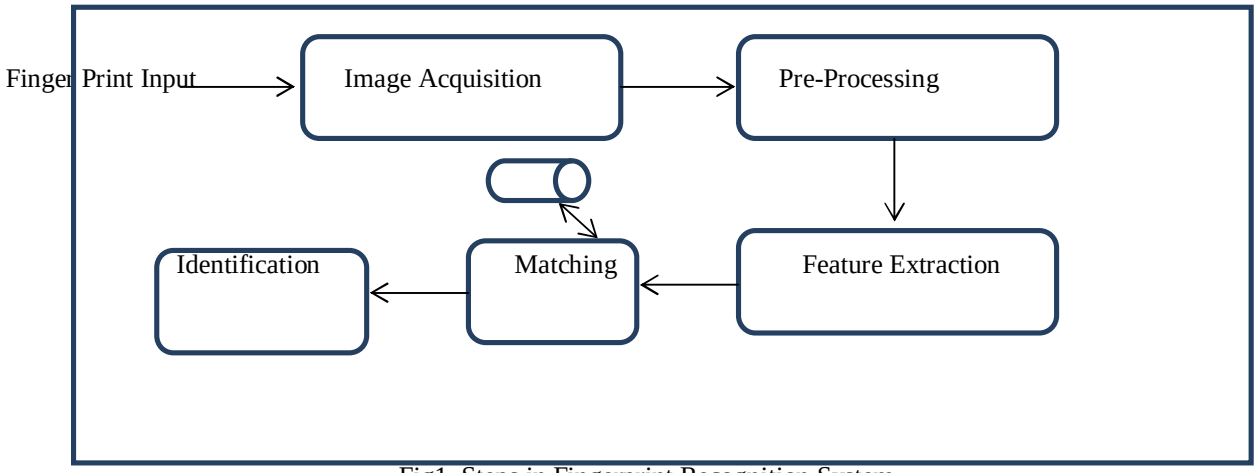


Fig1. Steps in Fingerprint Recognition System

A. Introduction

Finger Print Recognition system has the following chain of events (Fig1):

1) Image Acquisition
2) Image Pre-Processing
3) Feature Extraction
4) Matching
5) Image Identification

Image Acquisition is the first stage in the fingerprint analysis. Various methods have in place for image acquisition. They are Ink impression method, Optical Fingerprint capture devices, Solid State Sensors and Ultrasonic Scanning methods. The Live Scan method or Ink Impression is oldest method used and has been outdated due to its inefficient clarity and heavy workload to make it a quality image. Optical devices are next famous device to capture the images and it available from last four decades. It works on the principle of using a laser light allowed to pass through a glass surface and produces the image. The images are being captured using the principle Frustrated Total Internal Reflection (FTIR). More advanced technologies like using Optical Fibres are available to acquire more sharped images. Solid-state devices such as using chips have been the one of the advanced means in image acquisition which uses electrical technology. The technology is being implemented using Capacitive Sensors which creates a sensing surface using voltage capacitors. The image is being captured by varying voltage generated by capacitor surface. The very latest trend in Finger print acquisition is by using Ultrasound techniques. A beam of Ultrasonic waves which produces scanned images using echo signals. This is one efficient method of image capturing due to its sharpness and being less affected by various skin conditions such as accumulation of dirt or oils. It produces more realistic images compared to other methodologies. [1]

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B. Pre-Processing

The process of applying the filters and enhancing the images is (Pre-Processing) the next step in fingerprint identification. The main purpose of image enhancement is to avoid the noises in the fingerprints. Image enhancement helps in manipulating the image so as to improve the quality better than the original image which can be used for next level process. In this process the image factors such as brightness and contrast are adjusted to suit to needs of system. Pre-processing consists of various stages such as enhancement and binarization there are two types of basic enhancement techniques used; that are Grey scale and Binary Ridge Image. Grey scale is used to improve the frequency and orientation. Binary Ridge is a two level enhancement method which converts the images into binary format (0 and 1). It converts image into 1 bit image with 0 for ridges and 1 for furrows. Various methods of image enhancement techniques are as follows: Histogram Modelling: In this technique image is being represented as relative frequency on various grey levels. Using this technique a uniform output can be generated in the form of histogram. Contrast improvement is one the main output of this method. Higher contrast is produced by adjusting every grey level of the acquired image. Lower areas will contrast enhanced to produce high quality image. Median Filtering: This method of nonlinear filtering process where image pixel is replaced by median around a window panel. The main aim is of using technique is to reduce the opposing noises. Pass Filtering: This method sharpens the edges of the image. Acquired images are processed by subtracting the blurred image to produce high pass image. Weiner Filtering: This pixel adaptive method is used to reduce the noise and blurness on images. Gabor Filtering: Gabor filtering is a linear filter obtained by multiplying a harmonic function with Gaussian function. It captures local orientation as well as frequency information from an image. This method can improve the ridges by preserving its natural structure. [2] Directional Filter: An enhancement based on multi resolution mainly for noise reduction. This method adopts splitting the images into frequency bands. The enhanced image bands are recombined to have final image. [3]

C. Feature Extraction:

Process of extracting the minutiae features from filtered image by using various algorithms. The features are extracted from Arch (Ridges enter from one side of the finger, rise in the centre forming an arc and then exit from other side), Loop (The ridges enter from one side of finger and form a curve and then exit from other side and Whorl (Ridges form circular around a central point on the finger). In this process the fine features is also extracted from Ridge ending (point of termination of ridge), Bifurcation (the point of splitting single ridge into two, Short Ridge (are ridges which are significantly shorter than the average ridge length of fingerprint and Core-point (is the top most part of inner ridge) Fingerprint feature extraction is done to achieve high-accuracy minutiae with varied quality fingerprint images, segmentation algorithm needs to separate foreground from noisy background which includes all ridge-valley regions and not the background. Feature extraction is classified into two classes, those that work on un-thinned binarized images and those that work on thinned binarized images. The following features are commonly extracted: Spatial Features is being characterised by grey level, amplitude and distribution. Amplitude represents the simplest and main features of the object like in X-Ray image it denotes absorption characteristics and provides differentiation of bones from tissues. [4] Transform Features of image carries domain information of data. Feature is being extracted by feature mask. Strong frequency models are used for edge and boundary detection and angular slits are used for orientation. [4] Edge and Boundary Features represents places of high contrast and produces varied picture quality. This method decreases the amount of data required and preserves the major properties of image. Edges are main concept here and they are scaled to identify area, perimeter and shape accurately. [4] Sobel Technique is an edge detection method which represents a pair of 3 convolution kernels. Kernel is rotated by 90◦. Edges are moved vertically and horizontally by placing them in perpendicular positions. The combined image provides absolute magnitude of the gradient at each point. [4] Robert technique: This is a 2D spatial gradient on an image. Spatial gradient of the image provides the pixel values on each point. 2*2 kernels are rotated by 90◦. [4] Prewitt technique: Similar to Sobel Operator used to detect the both edges of images and provides two component measurements. The sum of vertical and horizontal component indicates the intensity of other gradient in the current pixel. [4] Canny technique: Algorithm also called as optimal edge detector uses an optimal edge detector that is inclusive of most edges to reduce the error rate. Edges are marked as closed to each other to provide maximum localization. Marking is done on edges that only single edge for minimal response. [4] Colour Features: Colour creates a visual effect on objects from light emission, transmission and reflection. Colour indicates the extension of scalar to vector signals. Histograms are used to find the weakness of same colour on different things that can be equal. [4] Shape Features: Representation of physical and profile structure. Main purpose is to identify matching shapes, object identity and measuring of objects using the attributes such as Perimeter, area and orientation. The measurement of shape is based on its external boundary and properties such as colour, content and composition and other spatial properties. [4] Texture Features: Representation of object features such as external characteristics, appearance attributes such as size, shape, density, arrangement and elementary parts. Texture feature extraction involves the

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collection of above attributes. Texture is widely used in areas such as remote sensing and medical imaging. Texture analysis involves classification, segmentation, synthesis and shape. Classification provides an image in which each texture can identified and type of class it represents. [4] Structural Feature Extraction: Representation of texture on accurate primitives and its hierarchical spatial arrangements. It provides symbolic details of image and mainly useful in synthesis and analytical tasks. Due to it variability it is not recommended that requires micro texture and macro texture. [4] Statistical Feature Extraction: In this method of extraction various statistical properties to the non-deterministic properties that maps relationships between grey level of an image. Statistical methods are used to analyse spatial distribution of grey values; computing local features on each point of image and producing bunch of values from local features. [4]

Model based Feature Extraction: The way of synthesizing a texture using analysis tools such as fractal and Markov model of an image is known as model based extraction. Description of image as probability or linear combination to set of basic functions is used in this approach. The statistical quality of roughness on varied scales, self-similarity and texture analysis and differentiation. Auto Regressive (AR) and Moving Average (MA) are common two dimensional methods used in this approach. [4] Transform based Feature Extraction: This method resembles the features of texture that represents an image on a co-ordinate system. Gabor Filter is a best example of transform method where spatial localization is represented. Transform method involves the transformation of real images using filters and its energy calculation. This process done on whole image rather than doing in part of an image. [4] Chaincode processing: Chaincode representation of object contours is extensively used in document analysis. Unlike thinned skeletons, the pixel image can be fully recovered from the chaincode of its contour. In this method, the image is scanned from top to bottom and right to left. The transitions from white (background) to black (foreground) are detected. Run Representation: This method results in fast extraction of fingerprint minutiae that are based on the horizontal and vertical run-length encoding from binary images without a computationally expensive thinning process [2, 3]. Fingerprint images are represented by a cascade of runs after run-length encoding. Then runs' adjacency is checked and characteristic runs are detected. But all characteristic runs cannot be true minutiae. So, some geometric constraints are introduced for checking validity of characteristic runs. Crossing Number: This method involves the use of the skeleton image where the ridge flow pattern is eight-connected. The minutiae are extracted by scanning the local neighbourhood of each ridge pixel in the image using a 3X3 window. Morphology based: The technique develops structuring elements for different types of minutiae present in a fingerprint image to be used by the HMT to extract valid minutiae. Ridge endings are those pixels in an image which have only one neighbour in a 3X3 neighbourhood. [5] Haar wavelet: The Haar wavelet is a sequence of rescaled (square shaped) functions .For an input represented by a list of numbers, the Haar wavelet transform may be considered to pair up input values, storing the difference and passing the sum .This process is repeated recursively, pairing up the sums to provide the next scale, which leads to differences and a final sum. The Haar wavelet is also the simplest possible wavelet. Singular value decomposition is a numerical technique used to diagonalizable matrices in numerical analysis. It is an algorithm developed for a variety of applications. The singular value decomposition (SVD) technique has been successfully used in a variety of applications, such as data compression, pattern analysis and signal processing. It has been scientifically proved that slight variation in the singular values does not change the visual perception of the image. [6] A fingerprint orientation model based on 2D Fourier expansions (FOMFE) in the phase plane. The FOMFE does not require prior knowledge of singular points (SPs). It is able to describe the overall ridge topology seamlessly, including the SP regions, even for noisy fingerprints. FOMFE can significantly improve the accuracy of fingerprint feature extraction and thus that of fingerprint matching. Moreover, the FOMFE has a low-computational cost and can work very efficiently on large fingerprint databases. The FOMFE provides a comprehensive description for orientation features, which has enabled its beneficial use in feature-related applications such as fingerprint indexing. Unlike most indexing schemes using raw orientation data, we exploit FOMFE model coefficients to generate the feature vector. [7] Another method on Fingerprint classification based on discrete Fourier transform (DFT) and nonlinear discriminant analysis. Utilizing the DFT and directional filters, a reliable and efficient directional image is constructed from each fingerprint image, and then nonlinear discriminant analysis is applied to the constructed directional images, reducing the dimension dramatically and extracting the discriminant features. The proposed method explores the capability of DFT and directional filtering in dealing with low-quality images and the effectiveness of nonlinear feature extraction method in fingerprint classification. [8]Fingerprint recognition based on features extracted from the wavelet transform of the discrete image based on the wavelet features are extracted directly from the gray-scale fingerprint image with no pre-processing (i.e. image enhancement, directional filtering, ridge segmentation and ridge thinning and minutiae extraction). This method has been tested on a small fingerprint database using the k-nearest neighbor (k-NN) classifier. The very high recognition rates achieved show that the proposed method may constitute an efficient solution for a small-scale fingerprint recognition system. [9]

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Delta Point (is the tri-radial point in which 3 ridges are radiating.[10] The core and delta locations can be used as landmark locations by which to orient two fingerprints for subsequent matching - though these features are not present on all fingerprints. There may be other features of the fingerprint that are used in matching. For instance, pores can be resolved by some fingerprint sensors and there is a body of work (mainly research at this time) to use the position of the pores for matching in the same manner that the minutiae are used. Size of the fingerprint, and average ridge and valley widths can be used for matching, however these are changeable over time.[2]

II. DIFFERENT APPROACHES ON FINGERPRINT IDENTIFICATION

For pattern matching various techniques are widely used. Important fingerprint matching techniques are: Correlation Based Matching: Approach of comparing two images by pixels which is computed for different alignments and rotations. The main disadvantage of correlation based matching is its computational complexity [11]. K. Abbad et.al in [12] used correlation method to improve the temporal performance. The correlation method is proved better than minutiae-based methods because of their temporal performances but very time consuming at the same time. Asker et.al[13] proposed a correlation-based fingerprint verification system that uses the richer gray-scale information of the fingerprints. There is one practical drawback to this method. The template locations are obtained by means of template matching. If a template is scaled or rotated more than some constant, it is not possible anymore to localize it in the secondary image. Weiping et.al [14], proposed a minutiae based Finger Print Matching Algorithm Using Phase Correlation that uses the phase correlation (PC) method which is a popular choice for image registration because of its robust performance and computational simplicity. The computation of this proposed method is simple without the need of searching for corresponding minutiae pairs. By using locations and directions of sparse minutiae points in fingerprints, which greatly reduce the storage space compared to current phase-based fingerprint matching techniques.

Minutiae Based Matching: This is the most popular and widely used technique, for fingerprint comparison. Finding minutiae points from a raw image for which mapping is required is the first step in this technique. However, there are some difficulties when using this approach. It is difficult to identify the minutiae points accurately when the fingerprint is of low quality. [11]

According to Naser et.al [15] a binary ridge image is an image where all the ridge pixels are assigned a value one and non-ridge pixels are assigned a value zero. The binary image can be obtained by applying a ridge extraction algorithm on a gray-level fingerprint image. Since ridges and valleys in a fingerprint image alternate and run parallel to each other in a local neighborhood, a number of simple heuristics can be used to differentiate the spurious ridge configurations from the true ridge configurations in a binary ridge image. Ceguerra et.al [16] a new approach for combining local and global features for AFV systems was developed. It uses matched local features as the reference axis for generating global features. Any local and global recognition schemes can be combined in this way. Minutiae based and shape-based algorithms were integrated. The first one matches local features by using a point-pattern matching algorithm. The second one generates global features by using the matched minutiae as its frame of reference. Jin et.al [17] new fingerprint matching algorithm using the elaborate combination of minutiae and curvature maps from fingerprint images is proposed in this paper. First of all, we propose a simple method for curvature calculation based on fingerprint orientation fields from fingerprint images. For each minutiae, we perform the sampling operation on its curvature map around the minutiae. All of sampling points of each minutiae can be sorted with respect to the position and the orientation of the center Minutia For each minutiae, the sampling operation does not stop until all of the sampling points positioned on some circle fall into the fingerprint background area. Jea et.al [18] present an approach that uses localized secondary features derived from relative minutiae information. A flow network-based matching technique is introduced to obtain one-to-one correspondence of secondary features. Our method balances the trade-offs between maximizing the number of matches and minimizing total feature distance between query and reference. Fingerprints minutiae matching algorithm has to solve two problems: correspondence and similarity computation. Feng [19] used each minutia two descriptors: texture-based and minutiae-based descriptors, and use an alignment-based greedy matching algorithm to establish the correspondences between minutiae. For the similarity computation, we extract a 17-D feature vector from the matching result and convert the feature vector into a matching score using support vector classifier. The proposed algorithm is tested on FVC2002 databases and compared to all participators in FVC2002.Ridge Based Matching: Ridge based technique compare the basic fingerprint patterns (arch, whorl, and loop) on a previously stored template with a selected fingerprint. Images are placed in plane orientation and matched with template to conclude angle of the match. Template generally includes type, size, and orientation of patterns within the aligned fingerprint image. [20] In Iancu et.al [21] Fingerprint Identification using a Fuzzy Logic System uses an optimized method to identify using Fuzzy fingerprints. To reduce the number of points Fuzzy logical reasoning with two set of matching values are used for better results. The advantage of this method over other classical methods is that it results in less number of calculations which improves efficiency of classifications. According to Hasma [22] uses

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an artificial Neural networks in bringing an efficient matching for authentication. In this work back propagation N.N. has been used as finger print classifier with time effective pre-processing. Using Back propagation it is identified that lesser response times in effective processing and improved prints for identification. Prasanna et.al [23] performed two module analysis on matching percentage and used fuzzy logic to improve the sharpness of edges. The matching contains 80 fingerprints of each 10 persons that segmented fingerprint increases the minutiae up to 20% and produced faster output time of .9 sec for each one. As per Purneet et.al [24] using fuzzy and other network has found to be effective; but highlights drawbacks such as false estimate of local ridge direction which can give poor quality enhanced images. Fingerprint techniques that use contextual filters or multi-colour filters on local ridge frequency orientation and highlight the enhancement of images where the most attention is needed. According to D. Ezilmaran et.al [25] uses a spatial model using Gabor Filter enhancement, Frequency domain and fuzzy model. This has improved the quality of images, its orientation and singular and intuitionist fuzzy. Ankit Mehta et.al [26] presents an improved and enhanced fingerprint image. The images are well processed using MATLB tool and implemented various algorithms and produced better quality images. This has helped in overcoming the drawbacks of spatial methods like thresholding, histogram and frequency domain methods According to Yang et.al [27] Fuzzy logic provides human reasoning capabilities to capture uncertainties that cannot be described by precise mathematical models. An Adaptive fuzzy neural controller methodology is used and 85% accuracy is obtained. The concept of fuzzy sets is applied to the extracted features and the quantitative feature values aredefined. In the feature matching stage, we introduce a weighted matching score using quantitative feature values to guarantee reliable matching results. Furthermore, a two-step estimation of transformation parameters is employed to reduce the computational complexity. The experimental results show that our system can achieve a fast personal identification with a good performance. [28] Rossini Velour[29] submitted a report in University of Texas El Paso on the topic of Fingerprint recognition using Fuzzy inference techniques. She develops the fingerprint recognition system using fuzzy inference techniques. The two principle components in this recognition system are the administrator, where templates are stored and the fingerprint recognizer. The author had implemented Matching Degree methodology and has achieved an accuracy of 90%. In the systems described in Tizhoosh et.al[3] and Lin et.al[31], all inputs to the fuzzy inference systems (FIS) system are obtained by applying to the original image a high-pass filter, a first-order edge detector filter (Sobel operator) and a low-pass (mean) filter. The whole structure is then tuned to function as a contrast enhancing filter and, in another problem, to segment images in a specified number of input classes. The adopted fuzzy rules and the fuzzy membership functions are specified according to the kind of filtering to be executed. It uses fast fuzzy edge detectors. Sagar et.al in [32]proposed an alternate approach for minutiae extraction using fuzzy logic and the same is proposed by Zadeh et.al in [33]. This approach strives to detect minutiae using the grayscales on the original fingerprint image. Although the results of the fuzzy approach are promising, care has to be excercised to sufficiently define the fuzzy rules to cover certain situations otherwise it results in false detection of minutiae.

According to Ayman et.al [34], the main power of fuzzy image processing is in the middle step (modification of membership values). After the image data are transformed from gray-level plane to the membership plane (fuzzification), appropriate fuzzy techniques modify the membership values. It uses fuzzy model reference learning controller methodology. This can be a fuzzy clustering, a fuzzy rule-based approach, a fuzzy integration approach and so on. According to H.S Kam et.al [35] Fuzzy smoothing of image by Gaussian as well as impulse noise is achieved by combining the output of several filters termed as hybrid filters. Impulse knowledge is achieved by combining the output of several filters called hybrid filters . Russo's algorithm is used and an accuracy level of 95% is obtained. The Neural Network Decision Stage methodology described by Baldi et.al [36] exclusively deals with the aspect of correspondence consists of two main steps, namely: a preprocessing step and a decision step. The preprocessing stage basically aligns the two images and extracts, from each one of them, a central region. The two central regions are fed to the decision stage, which is the proper neural network part of the algorithm and subject to training from examples and obtained accuracy is 96%.Thomas et.al in [37] has performed a classification or direct comparison which led to the recognition of the pattern between the input feature vector and the prototypes of the database. Logically connected neural network method is based on the locally connected neural network and is more appropriate for verification applications, security and identification. X Tan [38] suggested a feed-forward neural network which was trained to classify fingerprints on the basis of their discrete wavelet transforms. In the transformation process, Neto [34] assembled the feature vector using the 64 coefficients of the sub bands 0, 1, 2, and 3 of the transform [36]. Steady-state and Generational Genetic Programming method is used with a accuracy level of 93.3%. Maio et.al [39] who worked on self-organizing neural networks proposed a SPD Classifier that reduced the complexity (and thus the training time) of the network by applying a dimensionality-reduction technique to the feature vectors. C.L Wilson et al [40] worked on a simple neural network that reduced the complexity (and thus the training time) of the network by applying a dimensionality-reduction technique to the feature vectors.

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III. HYBRID METHODS

According to Tadvi et.al explores hybrid fingerprint matching system with the fusion of minutiae features and wavelet statistical features. The final matching score is calculated by fusing matching scores of the minutiae based method and wavelet based method. The performance of the proposed hybrid fingerprint recognition method can be evaluated by measuring its False Reject Rate (FRR) and False Accept Rate (FAR) as shown in the simulation results. Usage of this method found to be resulted in efficient than conventional minutiae based methods for real time authentication systems with large size databases. [41] As per [Brahnam et.al]proposes three hybrid approaches.The first approach is texture-based (TEX): the fingerprints are first aligned using the TICO approach, then each image is decomposed into overlapping square cells of dimension 50×50 (overlap=50%). We experimented with two descriptors: Local Phase Quantization (LPQ) and Local Binary Pattern Histogram Fourier (HF). The matching value between two images is calculated by the City block distance function. The resulting methods are named TEXLPQ and TEXHF.

The second approach is orientation image-based (OR): the fingerprints are first aligned using the TICO approach, then the orientation image is calculated and the orientation distance (minimal overlapping angle between two orientations) is calculated to perform the matching. The third approach is edge-based (ED): for each couple of minutiae (x, y) of the template T that are mated with a couple of minutiae (a, b) of the input image I, we extract LPQ descriptors from the regions a(x, y) from T and a(a, b). The similarity between two images is the average similarity (City block distance) among all couples of regions. [42] According to Atul Ganbawle [et.al] easy method for feature extraction fromfingerprint images is proposed. Fingerprint matching isdone using hybrid fingerprint matching using minutiae andtexture. The flow direction of the ridges is computedviewing the fingerprint image as a texture image. The inputimage quality did not affect the performance of hybridmethod. The Discrete Wavelet Transformation (DWT) was used to find the frequency domain vector by calculating energy values; Singular Value Decomposition (SVD) was implemented in order to find the spatial feature of the non-zero singular values. The outputs of PCA, SVD and DWT are combined to form the feature vector. The K-nearest neighbor classifier is used to classify the fingerprint .The system will recognize whether the output is match with training data. Result obtained from these techniques show an encouraging performance graph in terms of classification accuracy.[43]

IV. FUZZY NEURAL NETWORKS

Fingerprints are more utilized form of biometric identification method. Till present, there are various methods are available to identification and matching of fingerprints to establish individual identity. The current paper's focus is on identifying and studying various trends in fingerprint technology using Fuzzy and Neural networks. Main focus of this methodology to reduce the error factors in minutiae extraction. Fuzzy logic is a rigours mathematical method and it provides an effective in modelling the uncertainties in human reasoning. A fuzzy set is an object which is characterized by its membership function. The function is assigned to every object in the set and membership function is the grade of membership of that object in the mentioned set. A Neural network usually involves large number of processors operating in parallel and arranged in tiers. This model is similar to the way our human optic nerve receives signals from those close to it. A Fuzzy Neural network or neuro-fuzzy system is a learning machine that finds parameters of fuzzy system by exploiting the approximation techniques from neural networks. A fuzzy set is an object which is characterized by its membership function.That function is assigned to every object in the set and it is ranging between zero and one.A neural network usually involves a large number of processors operating in parallel and arranged in tiers. The first tier receives the raw input information -- analogous to optic nerves in human visual processing. Each successive tier receives the output from the tier preceding it, rather than from the raw input -- in the same way neurons further from the optic nerve receive signals from those closer to it. The last tier produces the output of the system. A fuzzy neural network or neuro-fuzzy system is a learning machine that finds the parameters of a fuzzy system (i.e., fuzzy sets, fuzzy rules) by exploiting approximation techniques from neural networks. According to Ching et.al [44] extracting the proper minutiae from fingerprints is a very important step in identification and may result in poor quality images. The noise in the images can result in poor quality images and cause extraction faults like false minutiae and this cannot be detected correctly. A Fuzzy feature encoder with help of core membership function based on precise mathematical models has helped to handle the faults in an effective way. Back Propagation Neural Network (BPNN) is an effective method used for variable fault tolerances and results obtained are fast, efficient and reliable. The experiments have proved that performance with Fuzzy and Neural Network the quality of image has improved. As per Assas et.al [45] using a Fuzzy Neural network has produced better results compared with other classification methods. This classification is based on fingerprint extraction involves encoding singular points. The values are measured in tended arch, whorl, left and right loop. The use of three comparison methodology namely Pedrycz Network, Fused compact Network and NEFCLASS network and these were tested on 200 sample images. An accuracy close 100% achieved and seen an increased credible output and found to

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better than general network for fingerprint classification. In various aspects the use Fuzzy-Neural networks found to be more efficient due to its close comparison logic between two sets. Also it gives us accurate results with reduced error factors so that fingerprint classification can be more efficient. Main advantage of using this methodology due to its close association with human methods and provide much reliable and faster algorithms.

V. CONCLUSION

Many techniques are available for fingerprint identification. Recent studies are putting emphasis on usage of hybrid techniques in fingerprint identification stages. Based on the survey of above papers in Fingerprint matching and classification the modern methods such as Neural and fuzzy network which works on the basic human principles and can provide better accuracy and reliable method for various fingerprint processing stages.

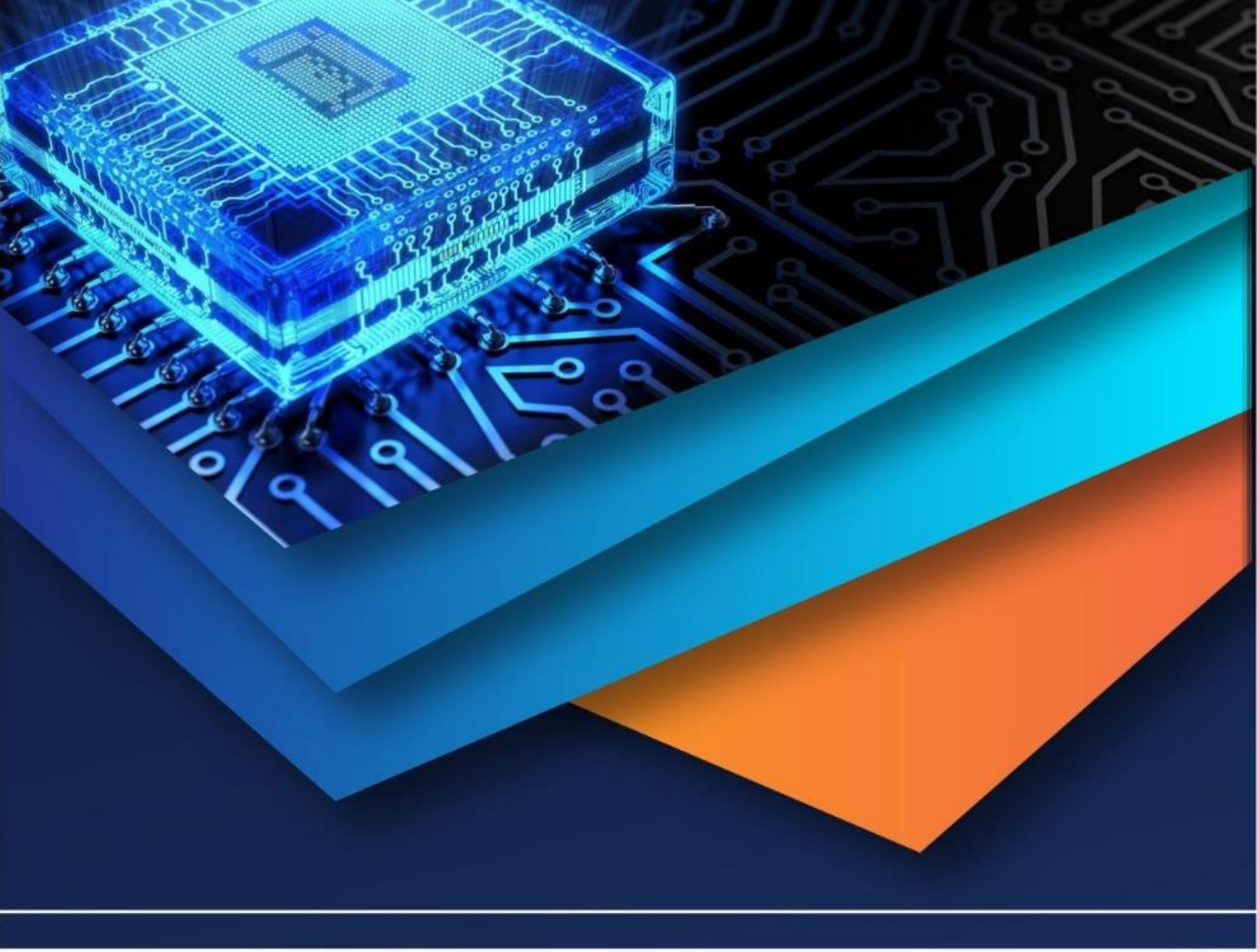
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