Latent Fingerprint Enhancement And Matching Using BPNN (Back Propagation Neural Network) Technique

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***Abstract*—** Fingerprint is an example of edges and valleys on surface of fingertip. Every person has distinguished fingerprints. The singularity of fingerprint is controlled by neighborhood edge qualities and their connections. Several neighborhood edge qualities (islands, short edges, walled in area and so forth.) have been recognized. These nearby edge qualities are not equitably conveyed. The majority of them is depends vigorously on the impression conditions and nature of fingerprints and are once in a while seen in fingerprints. An edge is characterized as a solitary bended portion, and a valley is the locale between two contiguous edges. The security measurement relies on knowledge-based methods such as token (swipe cards (credit cards) and passports to control access to physical and fundamental spaces), passwords (Net banking, ATM Cards). Through ever-present, such techniques are not secure mannerly. Passwords like as an access and badges cards might be shared or stolen. The fingerprint is the most famous biometric traits use for security and law-enforcement. The major drawbacks of image processing are: High cost depending on system used, loss of image in case of system damage, Compact storage and easily modifiable. In research work, introduce a novel method for fingerprint image enhancement depends on the SIFT and BPNN (matching and classification). SIFT algorithm to extract the features key-points forms. Classify the fingerprint image in noisy images and improve the accuracy and GAR. The proposed study and fingerprint enhancement method concurrently estimate various features of the fingerprint image like as a region mask. The BPNN classify the unique features in two phases: Training Section and Testing Section. In proposed system calculate the better performance with GAR 0.8 %, FAR value 1 to 5 per cent comes when BPNN+ SIFT and Gaussian filter is used for the improvement phase in classification fingerprint verification.

Keywords*—SIFT (scale invariant feature transform), BPNN (back propagation neural networks), ANN (artificial neural networks);*

I. INTRODUCTION

Image processing is a technique to play out a few activities on a picture, keeping in mind the end goal to get an upgraded picture or to remove some helpful data from it. It is a kind of flag handling in which input is a picture and yield might be picture or qualities/highlights related with that picture. These days, picture preparing is among quickly developing innovations. It frames center research zone inside building and software engineering disciplines as well [1]. There are two kinds of techniques utilized for picture handling in particular, simple and computerized picture preparing.

Image Enhancement procedures have been broadly utilized as a part of numerous uses of picture preparing where the subjective nature of pictures is critical for human understanding. Complexity is an imperative factor in any subjective assessment of picture quality. Differentiation is made by the distinction in luminance reflected from two neighboring surfaces. Our visual framework is sensitive to differentiate than outright luminance; numerous calculations for achieving contrast improvement have been created and connected to issues in picture preparing [2]. A Fingerprint is an example of edges and valleys on surface of fingertip. Every person has distinguished fingerprints. The singularity of fingerprint is controlled by neighborhood edge qualities and their connections [3]. Several neighborhood edge qualities (islands, short edges, walled in area and so forth.) have been recognized. These nearby edge qualities are not equitably conveyed.

The process of the Finger print Enhancement algorithm is shown in Fig 1.

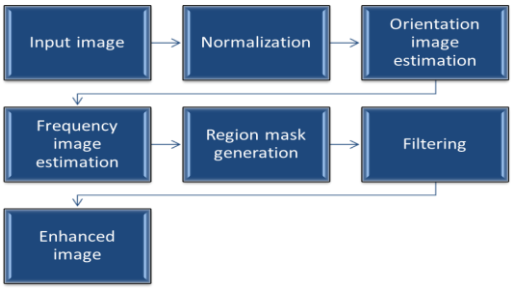

Fig1. Process of Fingerprint Enhancement Algorithm [5]

The majority of them is depends vigorously on the impression conditions and nature of fingerprints and are once in a while

seen in fingerprints. A decent quality unique mark normally contains around 40– 100 minutiae. The nature of unique finger impression pictures ought to be decreased because of clamor, skin conditions and so forth. Hence, enhancement procedure is required for upgrade the nature of fingerprint [4].

II. BACKGROUND

For the most part, for a given computerized unique finger impression picture, the locale of intrigue can be isolated into the accompanying three classes.

1) Well-characterized area, where edges and valleys are obviously separated from each other with the end goal.
2) Recoverable defiled area, where edges and valleys are debased by a little measure of wrinkles, etc.
3) Unrecoverable tainted locale, where edges and valleys are ruined by such a serious measure of clamour and twisting that no edges and valleys are obvious and the neighbouring districts don't give adequate data about the genuine edge and valley structures either.

The objective of an upgrade calculation is to enhance the clearness of edge structures of unique finger impression pictures in recoverable areas and to evacuate the unrecoverable districts.

A. Process of Finger Enhancement: The main ventures of calculation in finger enhancement are includes: [5]

1) *Normalization:* An information unique mark picture is standardized with the goal that it has a pre-specified mean and change.
2) *Local Orientation Estimation:* The introduction picture is assessed from the standardized information unique mark picture.
3) *Local Frequency Estimation:* The recurrence picture is processed from the standardized info unique finger impression picture what's more, the evaluated introduction picture.
4) *Region Mask Generation:* The district cover is acquired by grouping each piece in the standardized info unique mark picture into a recoverable or an unrecoverable square.
5) *Filtering:* A bank of Gabor channels which is tuned to neighbourhood edge introduction and edge recurrence is connected to the edge and-valley.

B. Noise in Images: Noise is an arbitrary variety of picture Intensity and noticeable as grains in the picture. It might emerge in the picture as impacts of essential material science like photon nature of light or warm vitality of pictures [6]. It might create at the season of catching or picture transmission. Noise expulsion calculation is the way toward expelling or decreasing the commotion from the picture [7]. Noise is presented in picture at picture procurement or transmission time.

1) *Types of Noise:* Noise is unwanted impacts delivered in picture. Amid picture securing or transmission, a few components are in charge of presenting Noise in the picture. Contingent upon the sort of unsettling influence, the commotion can influence the picture to various degrees. Several kinds of noise are discussed below:

a) Salt and Pepper Noise

The term motivation Noise is likewise utilized for this kind of commotion [8]. Different terms are spike commotion, irregular Noise or free commotion. High contrast spots show up in the picture because of this Noise and subsequently salt and pepper commotion. This Noise emerges in the picture on account of sharp and sudden changes of picture flag. Figure3. Demonstrate the impact of this commotion on the first picture (Figure 2).

Fig 2. Original Image without Noise [6], Fig 3. Image with Salt and Pepper Noise.

b) Gaussian Noise (Amplifier Noise)

The term ordinary Noise display is the equivalent word of Gaussian commotion. This commotion demonstrates is added substance in nature [9].Gaussian circulated commotion esteem. The commotion is free of power of pixel esteem at each point. The PDF of Gaussian arbitrary variable is given by:

$$P(x) = 1/\left(\sigma\sqrt{2\pi}\right) * e^{(x-\mu)2}/2\sigma^{2} - \infty < 0 < \infty$$

Fig 4, shows the effect of adding Gaussian noise to fig 2, with zero mean.

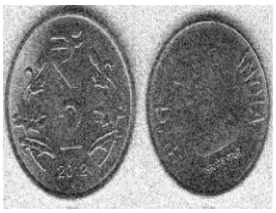

Fig 4. Gaussian Noise with Zero Mean [6]

c) Poision Noise: Poisson or shot photon Noise is the commotion that can cause, when number of photons detected by the sensor isn't adequate to give perceivable measurable data. This commotion has root mean square

esteem corresponding to square root force of the picture. At viable grounds the photon Noise and other sensor based commotion degenerate the flag at various extents [10]. Fig 5. demonstrates the consequence of including Poisson commotion.

Fig 5. Image with Poisson Noise [10]

d) Spot Noise

This noise can be displayed by irregular esteem duplications with pixel estimations of the picture and can be communicated as:

$$J = I + n*I$$

Where, J is the spot Noise dissemination picture, I is the info picture and n is the uniform commotion picture by mean o and fluctuation v. This Noise weakens the nature of dynamic radar and Synthetic opening radar (SAR) [10] pictures. This commotion is started in light of reasonable preparing of back scattered signs from numerous conveyed focuses.

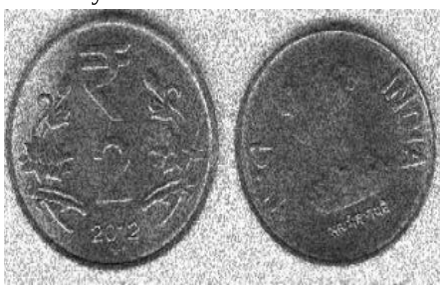

Fig 6. Image with Speckle Noise [6]

C. Filtration Methods: Image de-noising is critical undertaking in picture handling for investigation of pictures. Plentiful filtration calculations are accessible, yet the best one should expel the commotion totally from the picture, while saving the points of interest. De-noising techniques can be direct and in addition non-straight.

1) *Median Filters:* The Median channel is the prominent known request measurement channel in advanced picture handling. Middle channel is exceptionally famous strategy for the expulsion of drive clamor due to its great de-noising power and numerical precision. The estimation of a pixel is supplanted by a middle of the power levels in the area of that pixel by the Median Filter. A noteworthy preferred standpoint of the middle channel over direct channels is that the middle channel can dispense with the impact of information clamor esteems with greatly substantial sizes [11].
2) *Inverse Filters:* Reverse channel re-establishes an obscured picture impeccably from a yield of a quiet straight framework. Notwithstanding, within the sight of added substance repetitive sound, does not function admirably. Converse separating is the way toward recuperating the contribution of a framework from its yield. Backwards channel is acquired by partitioning the debased picture with the first picture in the 2D transform area [12].
3) *Bilateral Filters:* The thought fundamental bilateral filtering is to do in the scope of a picture what conventional channels do in its area. Two pixels can be near each other, that is, involve close-by spatial area, or they can be like each other, that is, have close-by values, potentially in a perceptually significant design. Specifically, reciprocal channels can be connected to shading pictures simply as they are connected to high contrast ones [13].

III. LITERATURE SURVEY

J. Shiny Priyadarshini, et al., (2017) [14] defined filtering methods to remove distortion and noise from blurred images. The singularity of fingerprint fortifies the identification marks. Contact less accession of fingerprints is becoming popular because it's easy to capture an image. Images would become blurred due to noise and distortion. They also highlighteddual enhancing techniqueto acquireclarity in image and extracting tabulated true minutiae points.

Kaifeng Wei, et al., (2016) [15] innovated an algorithm for fingerprint enhancement tocombine decomposition model of TV image and reconstruction of image with the help of orientation guided sparse representation. Latent fingerprints are impressions of finger skin that left accidentally at crime scene. Such fingerprints are generally of poor quality and ridge structure with several overlapping patterns. Initially, TV model is used to decompose latent fingerprint image tocartoon and texture components. Secondly, they calculate orientation field and reliability of texture image. Lastly, low unwavering quality district, inadequate portrayal in light of the repetitive word reference, which is built with Gabor capacities and the particular neighbourhood edge introduction, is iteratively used to recreate the picture. Simulated resulted relied upon NIST SD27 idle unique mark database show that the proposed calculation can evacuate different noises, as well as re-establish the ruined edge structure well.

HasanFleyeh, (2016) [16] presented a fresh approach to partition low quality fingerprint images gathered from low quality scanners. Such images are easy to gather yethard to

segment. The innovatedapproach focuses on segment and enhances such fingerprint images automatically to minimize the identification of false minutiae and improvise recognition rate. Four major contributions are: Initially, fingerprint images segmentation can be done by morphological filters to locate biggest object in image, i.e. base of fingerprint. Secondly, adaptive thresholding algorithm particularly designed to handle fingerprint images. The calculation tries to fit the curve among gray level of pixels in each line or section in fingerprint picture. The curve shows the finalization edge of each pixel in respective column or row. Thirdly, ridge enhancement and noise reduction is accomplished by summoning a rotational invariant anisotropic diffusion filter. At last, a versatile thinning calculation which is insusceptible against spurs is invoked to create the recognition ready unique identification image.

A. T. Gowthami, et al., (2015) [17] proposed fingerprint identification technique which uses linear binary patterns for identification and matching of fingerprint. Several applications used to identify humans relying upon their fingerprints. Fingerprint identification is popular biometric method used widely for individual's identification. A fingerprint image is segmented into 9 same sized zones. Each zone the binary patterns are distinguished and utilized for acknowledgment. Neural system and Euclidean separation closeness measures are utilized for acknowledgment. The proposed strategy is tested utilizing eight databases, involving 3500 examples altogether.

S. Neethu, et al., (2015) [18] presented a fingerprint enhancement technique based on FFT. Finger print enhancement is basic undertaking in the Automatic Fingerprint Identification System. The FFT is discovered after the unique finger impression picture is divided into pieces. Then it's increased with |FFT, where n is acquired by experimentation as 2.2. The best upgrade comes about were acquired for a square size of 4×4. In this approach, fixing of pore gaps in the edges and joining intermittent edges were accomplished. This strategy was contrasted and the distinctive traditional upgrade procedures.

IV. PROPOSED ALGORITHM

A. Sift Algorithm

Feature matching is a field of image processing which refer to various computer vision applications and in artificial intelligence mainly focus to compare the features of input image to the stored image [19]. Scale invariant feature transform is a kind of image matching algorithm. This algorithm is successful in the field of feature extraction. The process is invariant to scaling and rotation. The main work is to extract the local features of the image. This algorithm proposed by David. G. Lowe to capture the distinctive features from the local patches. Sift is a good algorithm preferred to large amount of feature points in feature extraction and feature matching.

Pseudo code : Scale Invariant Feature Transform

```
For octaves
{
List CKs;
For Scale
{
   Image GSS Parallel ();
Build
 DoG Parallel ();                // Detect KP

 # OMP Parallel,
 for
   All pixels S in image
{
 If
 IS CKs (S)
   # OMP Critical
CK. addition( S );
}
}
 # Program OMP parallel
  For all pixels CKs in KP;
 Down Sample  Image parallel ( );
}
```

In this code, KP is the key point list and CK are the candidate key points, Samp for the sample and it is fully based on if statements. This code is based on for loop and if conditions.

B. BPNN

Artificial neural network is a system of computing both hardware and software. The architecture of ANN dependent on the bio computation and information processing approaches. BPNN, back propagation neural networks is the branch of this network which has capability of learning and recalling [20].

This network is mostly preferred network and a best technique for feed forward training. The invention of BPNN was in 1986 by Rumelhart, Hinton and Williams. The process of learning errors is done by estimating the output errors to minimize the hidden layer errors.

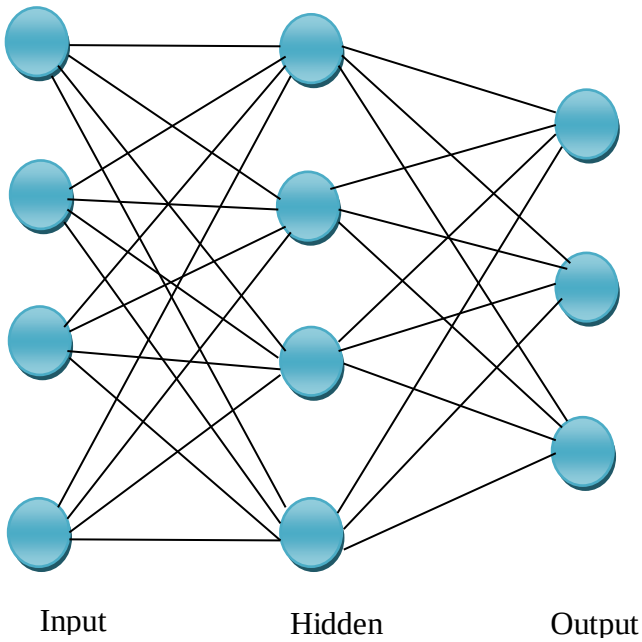

Fig 7. Architecture of BPNN

The architecture of BPNN is similar to the architecture of ANN (artificial neural networks). It consists of input layers and hidden layers in the centre and the output layers. The error rates are estimated through the calculations of output errors.

C. Fuzzy Method

The fuzzy systems got attention in the research and applications of computer vision applications.

Fuzzy system learns from the local learning methods which included the fuzzy rules and fuzzy sets. The purpose of using Fuzzy systems is to maintain the fuzzy controllers and fuzzy classifiers. Fuzzy sets- these are the sets whose elements have the membership degree and invented in 1965 by Dieter Klaua. Fuzzy rules are the kind of conditional statements set for the fuzzy classification. If the condition true, select the first element otherwise it goes to the other element [21].

Fuzzy classifiers are the classes used in the fuzzy systems to assign the labels. These classifiers are dependent upon the object description. The object descriptors are a set of vectors which includes the attributes. Training methods are used to learn the classifiers. It is processed also when the training set is unavailable and it data is fully based on the previous stored information.

V. METHODOLOGY

The proposed work explained in given steps in below: -

A. *Image Acquisition:* Initialize, we collect the data set from the UCI MACHINE LEARNING SITE repository site. Upload the fingerprint image from the dataset folder.

B. *Pre-processing:* In this pre-processing phase, convert the original image into grayscale form. Fingerprint image recorded by sensors on a satellite restrain errors regarded to the brightness values of the image pixels. In these exceptions are corrected utilized arithmetic structures which are either definite model. Fingerprint image enhancement is the alteration of image by modifying the image pixel brightness values to enhance its visual impression. Fingerprint image enhancement adds a collection of methods that are utilized to enhance the visual appearance of fingerprint image and convert the image to form which is better suited for machine interpretation.

C. *Filtration:* Image distortion filtrating is utilized to filter the unwanted information from an image. It is also used to remove the noise various types of noises from the fingerprint images. Normally, this feature is inter-active. Several filters like as low pass and high pass filter and Gaussian filter etc. The Gaussian filter is a linear-filter. It is normally utilized to blur the image or to optimize noise. If you utilize binary of them and sub, it could utilize them for un-sharp masking like as an edge detection method. The Gaussian filter alone would blur edges or regions and optimize the contrast.

D. *Feature Extraction using Hybrid approach:* Minutiae algorithm used for feature extraction with SIFT . Fingerprint image of an each is measureable as a unique and it remains un-changes over a life-time. If it doesn't have any severe damage cut or bruise. Image fingerprint are unique in twins. An image fingerprint impression is formed by the ridge and valley model on a finger-tip hide. A ridge is defined as signal curve part and a valley is the edge between twin's adjacent ridges. The valley and ridges model on every fingerprint image creates some different aspects which are portrayed minutiae feature extraction was carried out using the cross number method. The crossing number of image pixel 'P' is figure 3.3.1.

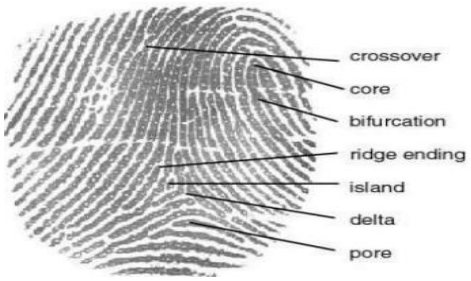

Fig 8. Features in Fingerprint Image

VI. Result Discussion

A. Design and Implementation

In this section, design and implementation using proposed work (Minutiae and SIFT, BPNN algorithm). To evaluate the performance parameters like false acceptance rate, genuine acceptance rate, accuracy and mean square error rate and compared with the existing work.

In minutiae algorithm, to extract the features like binary, thin and minutiae points shown in red and blue color. In this partial difference equation method to extract the features based on rows and columns (r*c) matrix.

In classification method, classify the feature based in two stages i.e., training section and testing section, to divide the features in the two form classes and groups.

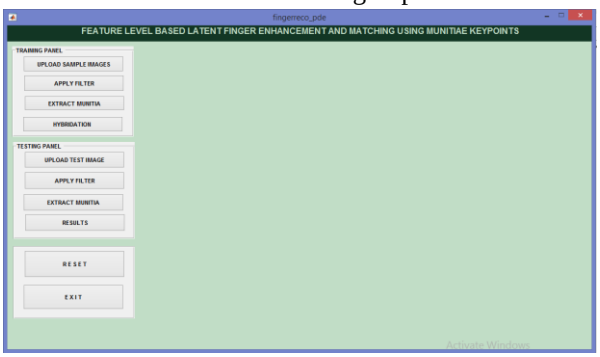

Fig 9. Training Section

The figure 4.1 defined that the training section. First phase, upload the sample image (UCI MACHINE LEARNING REPOSITORY). The fingerprint recognition that the distortion area and filtration method using Gaussian method. Extract the feature based on improve the scale variant feature transformation and Minutiae Algorithm. Classification, the feature based on back propagation neural network algorithm.

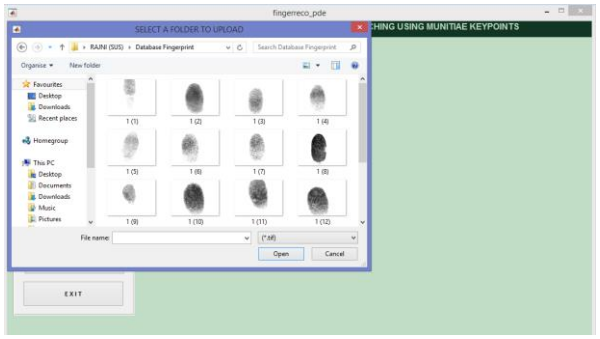

Fig 10. Upload the Image

The above figure 4.2 fingerprint recognition or enhancement that the upload the image from the dataset in training section. Select an image from the training section in the image 1 from the training database.

Fig 11. Original Image

The above figure defined that the upload image.

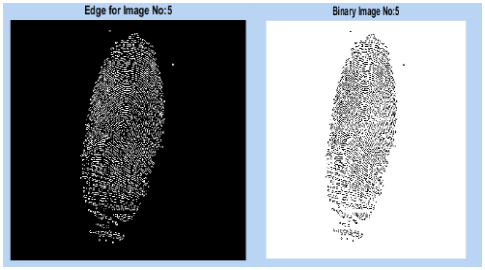

Fig 12. Edge Image and Binary Image using SIFT method

The figure shown that the minutiae algorithm to extract the feature based on detects the edge image and binary image. Edge Detection adds several of arithmetic techniques that objective at identifying points in DI (digital image) at which the image brightness modify suddenly or more correctly has dis-continuities.

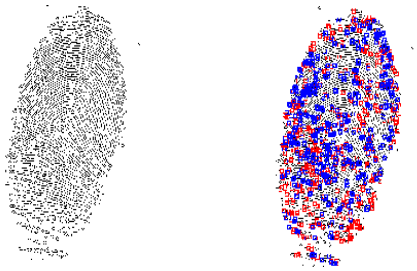

Fig 13. Thin image and Minutiae Points for feature extraction.

The above figure shown that the thin image and extracted feature using Minutiae algorithm. It extract the features based on loop, whorl, ridges and valleys in the fingerprint image. Thinning image is a transformation of an image into a easier but equivalent fingerprint image.The point where the ridge line-ends are known as termination and the point where a ridge line forks out twice lines are called bifurcation.

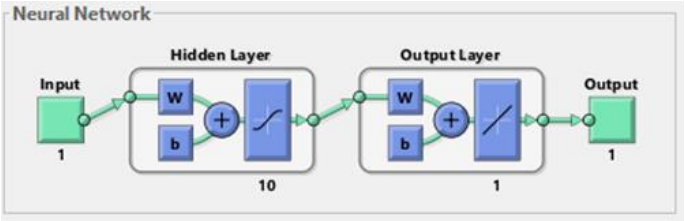

Fig 14. Classification

The above message box defined that the classification process has been completed. BPNN, back propagation neural networks is the branch of this network which has capability of learning and recalling. This network is mostly preferred network and a best technique for feed forward training. The architecture of BPNN is similar to the architecture of ANN. It consists of input layers and hidden layers in the center and the output layers. The error rates are estimated through the calculations of output errors.

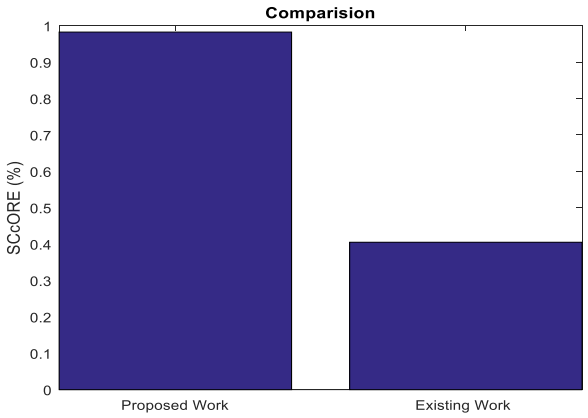

Fig 15. Comparison between proposed and existing work (SCORE)

The above graph shows the comparison between proposed and existing work in SCORE performance parameter. In proposed algorithm improve the SCORE rate using Improved BPNN (Back Propagation Neural Network) value is 0. 98 and Existing work Transformation method value is .42.

TABLE I. Performance Parameters in Proposed work

Parameters	Values
FAR	0.98
GAR	0.830
Score	98.58

TABLE II. Comparison (Proposed and Existing Work)

Parameters	Values
SCORE in proposed Work	.98
SCORE in existing work	

Above TABLE I and II defined that the performance parameters and comparison between proposed and existing performance parameters like SCORE, GAR and FAR.

VII. Conclusion and Future Scope

In conclusion of the fingerprint identification could become when a method or software finalizes the gaps between ridges. In this proposed work, SIFT method is used to extract the features and classification is used for completion of the fingerprint. SIFT operator can be used for fingerprint feature extraction and matching with proper pre-processing step. The complete proposed work is designed on the FVC2002_DB1 for the verification of the partial fingerprint image. The spaces are created in FVC2002 dataset fingerprint images to make them partial image. The spaces are filled with the help of SIFT + Minutiae and improved classification method with the filters. Feature extraction using Minutiae algorithm from both the real image and improved fingerprint image used for geometric alignment of these binary prints. The binarlization method is utilized for matching and to verify an each fingerprint image.

The False Acceptance Rate and Genuine Acceptance Rate are utilized for the performance calculation of the proposed work. The better performance with GAR 0.8 %, SCORE value is .98 and FAR value 1 to 5 per cent .

The future work can be further improved by following explanations: Partial latent is completed with Exemplar In painting and Exemplar results are not good on poor quality latent because it is completing the image with the present information available in the image. And in poor latent, the present information is very less. Therefore, completion of a poor quality latent is still a challenging problem. The pre-processing stage of proposed algorithm can be further improved by making segmentation and ROI automatically. Instead of using geometric transform alignment, high resolution pore valley descriptor partial fingerprint alignment can be used. It can propose a method of alignment with the extraction of pores from the partial fingerprint. According to the results of paper, PVD (pore valley descriptor) alignment improves the accuracy of high resolution partial fingerprint recognition. Therefore, by using PVD alignment in proposed work the performance of matching can be increased.

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