FACIAL-IRIS AUTOMATIC MULTIMODAL BIOMETRIC IDENTIFICATION SYSTEM USING AL-CNN METHOD

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Abstract: Nowadays, MMB (multimodal biometric) system has currently increased concern because of its capability for reducing particular intrinsic challenges of the SBM (single biometric modalities) as well as for enhancing the complete identification rate and time consumption. The basic BRS (biometric recognition system) comprises processing, FE (feature extraction), FS (feature selection), SLF (score level fusion), classification modules. The vigour of the MMB system is based on and more reliable to extract unique data from the SBTs (single biometric traits). This research model designed a novel AL-CNN method for MMBS (multimodal biometric system) by utilizing iris-facial traits. The iris and facial traits FE (feature extraction) are extracted utilizing an effective MR (multi-resolution) GF (Gabor Filter) to filter the text data in various orientations and scales. In this analysis, the KPCA algorithm is developed to extract the feature vectors or unique feature sets. The SLF (score level fusion) procedure of valuable feature sets from two extracted feature sets is merged at hybridization AL-CNN model. It has implemented the novel approach to calculate the valuable FVs (feature vectors) and classified the features. The simulation procedure is evaluated on FERET for face and CASIA v3 for iris image data set. The experiment results from analyses has improved the recognition rate of 97.97 per cent, time consumption 1.2 sec, mitigate the error rate, and compared with the existing method (FK-NN).
Keywords: *MMBS (multimodal biometric system), KPCA (kernel principal component analysis), FK-NN (Fuzzy K nearest neighbour), and AL-CNN (ant lion- convolutional neural network).*

I. INTRODUCTION

Traditional UBS (uni-modal biometric systems) utilize only one biometric trait. Such structures are restricted and face various issues like absence of distinctiveness, limited level of privileges, non-universality, intra-group discrepancy, noisy information, spoofing risk and inappropriate ERR (error recognition rates). A resolution to control such restrictions is the usage of different traits. On the basis of this concept, a MBS (multimodal biometric system) is acquired by fusing the withdrawn data from various biometric traits [1], [2], [3]. Normally, the fusion method in this structure can happen in four stages: SL (sensor-level), FL (feature-level), SL (score-level) and DL (decision level) [4], [5].

Figure 1. Illustrations of characteristics biometrics

Recognizing a person by utilizing their bodily or behavioural attributes are gaining importance in various locations like airports, buildings which need more security at entries, ATM machines, etc. MBS is utilized in these locations for individual verification for getting greater performance verification structure. Biometric verification models utilize physical and/or behavioural attributes which are distinct and cannot go missing or are irrecoverable. Voice, face, handwriting, iris, fingerprint, and other attributes can be utilized in a uni-modal or multimodal design for authentic as well as safe verification of an individual [6].

The facial trait is the quite normal method for an individual verification while iris trait is among the most correct biometrics modality. Combining iris and facial traits gives greater identification performances [5]. The benefit is to utilize a single sensor for representing the iris and face, in which the iris is taken out from the encapsulated facial image.

Face verification has been widely surveyed by various analysts in the past. A evaluative analysis of investigators over pose on facial images has been carried out by Zhang and Gao.[7] They categorized the current methods over pose in three classes in accordance to their techniques, i.e. general methods, 2D methods and 3D techniques. The benefits as well as restrictions of every class are examined as well as outlined in their research for giving various encouraging regulations for later studies of face identification over pose. [8] A new 3-dimensional face restoration technique based upon a photometric stereo is suggested to retrieve the 3-dimensional form of a face by assessing the surface normal from shading data in different images. For assessing the surface normal they integrated the lightened models by using familiar lighting situations from input images.

Iris identification has been reviewed in various aspects in the past. Daugman in [9] and [10], executed a large research on iris identification methods as an authentic biometrics, as well as discussed a technique based upon the non-success of a analytical examination of freedom for quick optical identification.[11] Daugman suggested an integral-differential operator for searching the iris internal as well as external edges.

Multimodality is competent for resolving issues linked to uni-modal biometrics which influence the accomplishment of structures like destructions, absence of discreteness, non-universality, and noisy information. [16] For example, in face identification, dissimilarities regarding lighting, pose and expression causes deterioration of performance [16] and in iris identification, inconsideration conditions may deteriorate iris identification correctness. [17] In reality, multimodal biometrics fusion method takes out data from various biometric modalities for enhancing the identification performance as well as dealing with the restrictions of individual biometric modality.

Multiple MBS based upon facial and iris traits have been suggested in the past. To indicate a little, **Morizet and Gilles** in [11] suggested a structure on the basis of wavelets and statistical moments as attributes utilizing a SL fusion. ***Eskandari and Toygar*** in [5], merged the two traits by weighted amount principle in SL fusion. In [12] the authors suggested a structure based upon SL fusion and FL fusion. In ***Khiari-Hili et al.,*** [13] combined the facial as well as iris in SL fusion. In [14] both iris and facial traits are integrated with bin based classifiers in SL fusion. In [15] iris and facial traits are merged on the basis of FL fusion, SL fusion as well as DL fusion. The FE (feature extraction) and FS (feature selection) are the main concepts of the unique feature calculation and reduction procedure, in that, an initial set of the data is separated and optimized to more practicable clusters. It is a simple process and the main significant feature of these databases (FERET and CASIA) is that they have a huge number of variables. The classification process is classified the feature vectors and calculate the system performance.

Sections are organized as follows: Section 2 explained the various techniques and methods used in MBBS (multimodal biometric system). Section 3 and 4 discussed the proposed methodology with stepwise and experiment result analysis (mathematical formulas, result in analysis, and comparative analysis). Section 5 defines the conclusion and future scope of the research work in the Facial-iris MMBS identification system.

II. RELATED WORK

Mahmoud, R. O., et al., (2020) [18] proposed a MB (multimodal biometric) validation technique for verifying the specifications of a human-being on the basis of on his iris as well as facial characteristics. This technique was dependant on various biometric methods which merged facial and iris (left and right) characteristics for validation. The framework for recognizing people was based upon taking out the characteristics of the face by utilizing R-HOG (rectangle histogram of oriented gradient). A characteristics-based fusion utilizing a new fusion technique that made use of both the canonical correlation activity as well as the proposed serial concatenation was implemented. An extensive belief network was utilized for the identification procedure. The accomplishment of the suggested framework was verified as well as estimated by a set of tests on SDUMLA-HMT database. The outcomes were matched with other methods, as well as proved that the fusion time was decreased by 34 per cent. The suggested method was successful in attaining a lesser EER (equal error rate), and recognition precision of 99 per cent. ***Ammour, B., et al., (2020) [19]*** described that a novel FE (feature extraction) method that may be utilized for MMBS (multi-modal biometric system) which used iris and facial modalities. A systematic multi-resolution two-dimensional logarithm GF (gabor filter) was used for capturing iris FE, which captured multiple scales and orientations of textual information. For computing facial features, NIG (normal inverse gaussian) analytical attributes were derived from wavelet transform which were combined with SSA (singular spectrum analysis). Score and decision fusion methods were used for fusion of face–iris features. CASIA-ORL Iris and CASIA-FERET facial data sets were used for performing experiments. The proposed system improved performance of uni-model biometrics such as iris, facial, fingerprint etc. These databases gave higher RR (recognition rates) of 99.1 per cent and 99.3 per cent with minimum-maximum normalization and max rule fusion. ***Gupta, K., et al., (2019) [20]*** presented a MBS (multimodal biometric system) that appropriately merged the scores from independent classifiers for tackling the problems related to spoofing attack and noisy input image in a safety-crucial framework. 3 traits such as iris, facial and finger were utilized for taking out independent classifier scores. Such classifier scores were appropriately merged keeping in consideration that simultaneous traits were improved as well as contradictory traits was conquered. The varying belief between classifiers was solved to attain optimal fusion of classifier scores as well as to provide dynamic surroundings. The suggested standard based score fusion even differentiate in spoofing attacks and noisy inputs. The accomplishment of the suggested BMS was verified with the help of 3 databases. The given method attained 99 per cent precision, 0.5 per cent EER and performed better than modern techniques. ***Regouid, M., et al., (2019) [21]*** proposed a novel MBS (multimodal biometric system) based ECG-ear-iris biometrics at characteristics stage. Pre-processing methods consisting of normalization as well as segmentation were implemented to ear, iris and ECG biometrics. After that, LTD (local texture descriptors) such as 1D-LBP (one d-local binary patterns), shifted-1D LBP and 1D-MR-LBP (multi-resolution) were utilized for taking out the key characteristics from the ECG sign and alter the iris and ear images to a 1D signs. KNN (K nearest neighbours) and RBF (radius basis function) were utilized for matching to arrange an unfamiliar customer in the real or fake. The created framework was verified by utilizing the standard ID-ECG and USTB1, USTB2 and AMI ear and CASIA v1 iris databases. The test outcomes showed that the given method performs better than UBS (unimodal biometric system). CRR (Correct Recognition Rate) of 100 per cent was attained having EER (Equal Error Rate) of 0.5 per cent. ***Abozaid, A., et al., (2018) [22]*** described an efficient MB (multimodal biometric) verification method for validation of persons on the basis of voice and facial identification. Cepstral coefficients and statistical coefficients were used for taking out characteristics of voice identification as well as the two coefficients were contrasted. Face identification characteristics were taken out by using various methods like Eigen face and PCA (principle component analysis) and comparison of outcomes was done. Voice and face recognition traits were executed utilizing 3 classifiers, GMM (gaussian mixture model), ANN (artificial neural network) as well as SVM (support vector machine). The collaboration of biometrics systems, voice and face, into one MB framework was done by utilizing characteristics fusion and scores fusion. The computer simulation tests showed that better outcomes were attained when using for voice recognition the cepstral coefficients and statistical coefficients and in the event of face, Eigen face and SVM tests generated good outcomes results for face identification. In the suggested MB framework the scores fusion gave better outcomes than various other structures. Table 1 explained the comparative analysis with several parameters, methods, problems/gaps, and Further enhancements.

Table 1 Comparative Analysis

Author Name	Year	Methods and Biometric Traits	Problems/gaps	Parameters	Further Enhancements
Mahmoud, R. O., et al.,[18]	2020	R-HOG (rectangle histogram of oriented gradient), PCA (principal component analysis)	Security attacks	EER (equal error rate), recognition Accuracy, fusion time, FRR (false rejection rate), FAR (false acceptance rate, Error	Merging various kinds of biometric systems other than face and iris, following hybrid fusion method, utilizing greater database and developing this work to be more secured
Ammour, B., et al., [19]	2020	Gabor filter, NIG (normal inverse gaussian), SSA (singular spectrum analysis).	HD (high dimensionality) of extracted features causes issues of competence and efficacy in the learning process	RR (recognition rates)	It will design a DL method to extract the HL (high-level) features from data.
Gupta, K., et al, [20]	2019	Segmentation, Gabor filters, g finalisation and thinning operations	universality and optimization problem	Accuracy, EER (equal error rate),	Estimation of reliability on the basis of system's performance for each user
Regouid, M., et al., [21]	2019	Normalization, segmentation, KNN (K nearest neighbours) and RBF (radius basis function)	complicity weaknesses of a multimodal system	CRR (correct recognition rate), EER (equal error rate)	Detection of various emotions using bio signal ECG for enhancing security, validate work on larger databases
Abozaid, A., et al., [22]	2018	Eigen face, PCA (principle component analysis), (gaussian mixture model), ANN (artificial neural network) as well as SVM (support vector machine)	Problems in using voice as biometric verification are: speech variability, less security, poor precision, facing cross channel situations	ROC (receiver operating characteristic) curve, ERR (equal error rate), FAR (false acceptance rate), FRR (false rejection rate)	The proposed model will improve the system performance and existing problems.

III. RESEARCH METHODOLOGY

This research proposes MMBS (multimodal biometric system) depends upon Facial as well as Iris modalities as defined in fig. 4. The research model is explained as well as brief explained in this segment.

- *Image Acquisition:* Firstly, for research work downloaded the dataset CASIA for Iris and FERET for facial datasets. These datasets are used for authentication in multimodal biometric systems. It is uploading the input (*.jpg and *.pgm) image format. It converts the RGB image to a grayscale image. This conversion uses to reduce the dimension sizes in the uploaded image. After that, initial adds the artificial noises to identify the background noises in the image. It applies the GABOR filter method to eliminate the noises in the uploaded image and calculate the smooth image.

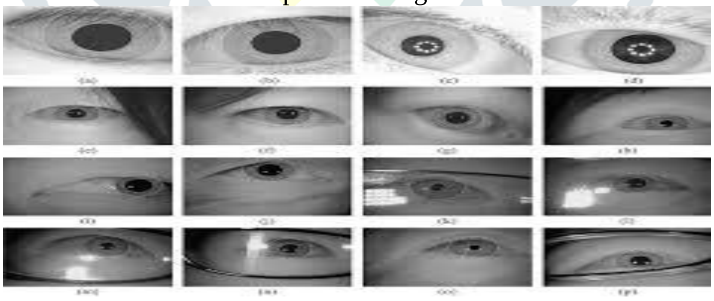


Figure 2 Iris CASIA V3 dataset Images [23]

Figure 3 FERET Facial dataset images [24]

- *Multimodal Biometric face and iris image pre-processing:* In this step, main objectives to execute the facial and iris images for improving their image standard as well as to fetch the edges. The iris and facial is measured as the most vital portion of the human body. It is improved by applying the Gabor filtration and black and white image extraction that normally maximizes the global and local features of the images. Formerly, the facial image is considered using the center locations of the R and L eyes that are detected by the KPCA method. The local features of the facial image such as the nose, lip, mouth, etc are identified with a similar method. Fig 5 shows the pre-processing steps of facial and iris recognition.

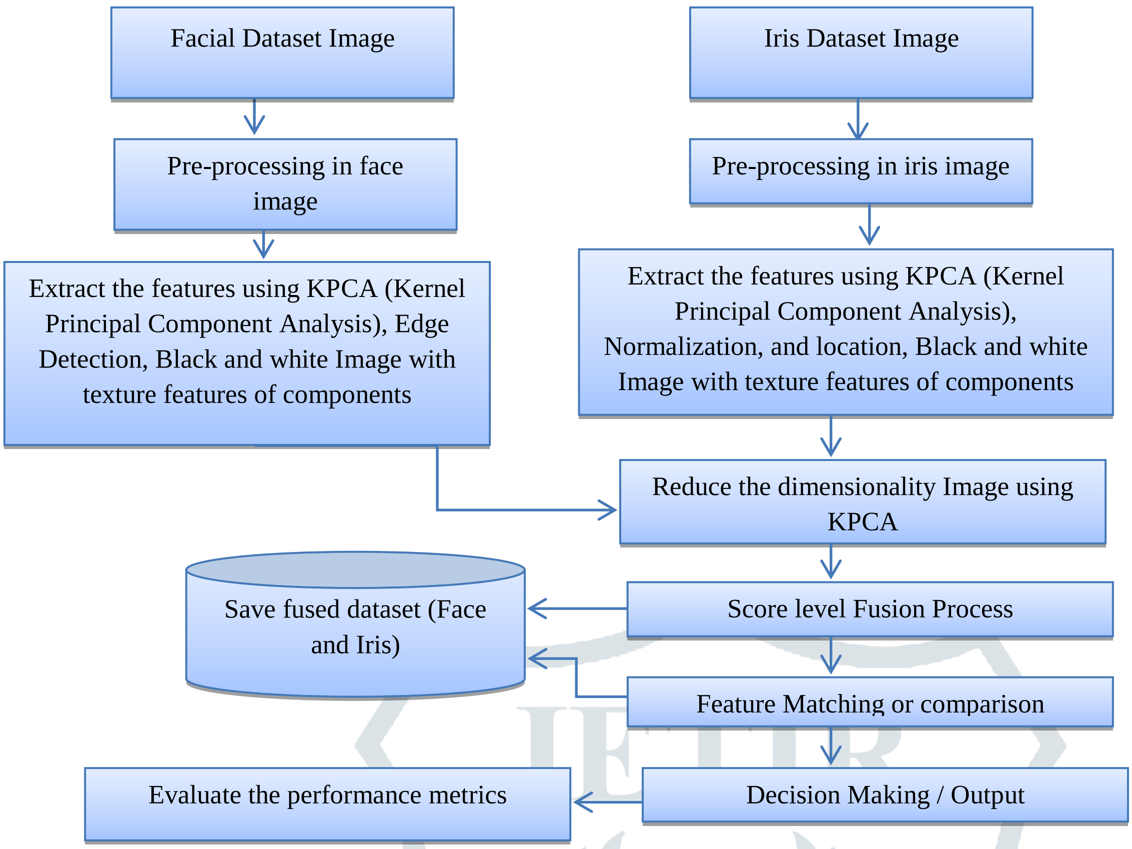


Figure. 4 Proposed model and Block diagram multimodal biometric system

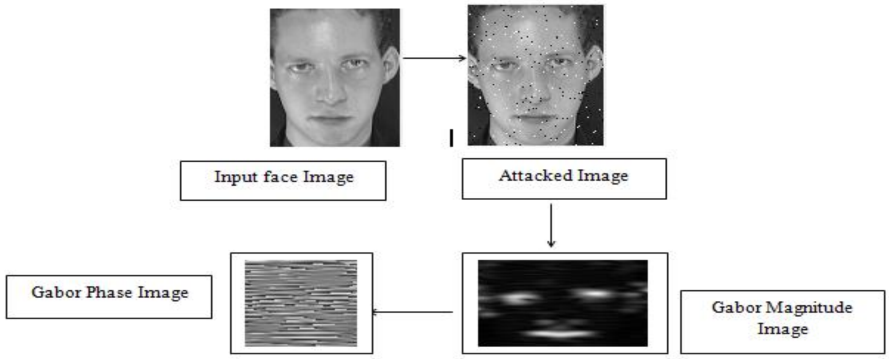


Figure 5. Iris Pre-processing steps

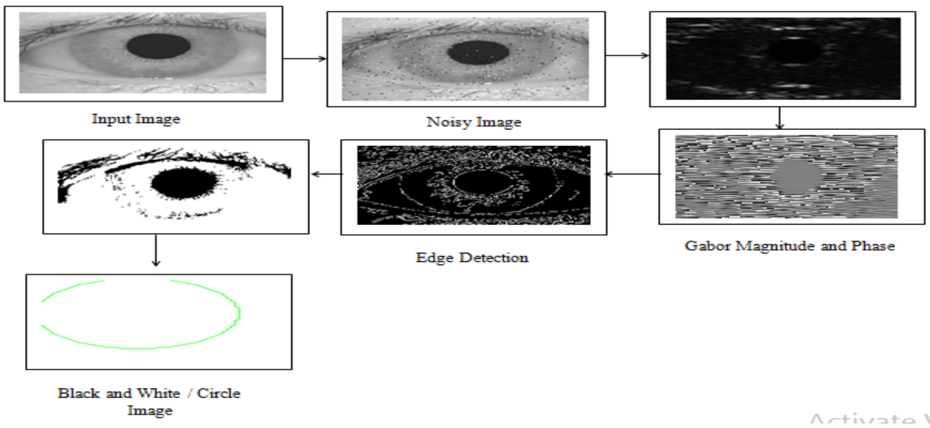


Figure 6. Iris Pre-processing steps

This research proposes two circles with the boundary detection and circle of the pupil area. There are two phases for identifying iris area, diameters, or pupil boundaries.

1. Searching the region of the iris areas, it used by the HCT (Hough circle transformation) to search the pupil iris circle co-ordinates.
2. Segmented image calculated, normalized and localization iris image shows in fig 6.

- *Feature extraction using KPCA:* PCA is a linear format approach i.e., it may only be functional to databases that are linear division. KPCA method utilizes a KF (kernel method) to database into an HD (high dimensional) FS (feature space), where it is linear separately. It is the same as the aim of the classification model. It extracts the unique feature vectors in the term of matrices (rows and columns). This method is calculated the HD of extracted features, it resolves the existing issues, and improved the recognition rate of the multimodal biometric system.

- *Optimized CNN algorithm (Ant-CNN):* The research system operates in verification and authentication module, in which the FVs (feature vectors) are contrasted to save the feature, sets in the data set for individual biometric modalities at the time of enrollment phase. Between the most important novel ant-CNN models used for classification. It searches the ALO algorithm to select the extracted feature sets; though, this proposed work implemented and improved the ant lion optimization with the CNN for the MMB structure for the classification or identification module.
- *Fusion Procedure:* This is the main procedure of the research MMB system. It depends on the efficient hybridization of facial and iris modalities. In this research work, the MMB system utilizes score-level and decision–level fusion at a similar time in order to achieve the merits of individual fusion and enhanced the system accomplishment. In this research model has implemented the score-level fusion, the scores are coordinated with the minimum, maximum, sum, and weighted sum rule methods. But this fusion is evaluated with different metrics.
- *Performance Metrics:* In this research work evaluated the system performance with the minimum, maximum, sum rule, weighted rule, and recognition rate and time consumption. It compared with the existing method such as the fuzzy-knn model.

IV. EXPERIMENTAL ANALYSIS

The research mathematical formulas are explained. It selects two types of datasets such as FERET [23] and CASIA [24] images for training and testing.

4.1 Mathematical Analysis

The research fusion methods was developed that a minimum, maximum, sum, weighted sum, recognition rate and time consumption metrics calculated with the system performance. The fusion principles used were explained by the following equations.

- *Sum Rule:*

$$F_i = \sum_{M=1}^{m} N_i^M \ , \forall_i \quad \ldots\ldots\ldots\ldots\ (i)$$

- *Max Rule:*

$$F_i = \max(N_i^1, N_i^2, \ldots\ldots\ldots\ldots, N_i^m), \forall_i \ \ldots\ldots\ldots\ldots\ (ii)$$

- *Min Rule:*

$$F_i = \min(N_i^1, N_i^2, \ldots\ldots\ldots\ldots, N_i^m), \forall_i \ \ldots\ldots\ldots\ldots\ (iii)$$

- *Weighted Sum Rule:*

$$F_i = W_1 N_i^1 + W_2 N_i^2 + \cdots \ldots \ldots \ldots \ldots + W_i^m \ \ldots\ldots\ldots\ldots\ (iv)$$

Here eq (i), (ii), (iii), and (iv) defines the normalized score for matching m = 1,2,3…… m, where m is the matched features implemented to consumers in which (i=1,2,3 ,………………..I) is the count of persons in the dataset.

- *Recognition Rate :*

It is defined as the total number of appropriately authenticated facial and iris images divided by the total number of analysis face and iris images.

$$Rec_{rate} = \frac{Au_{totalImages}}{An_{totalimages}} \ \ldots\ldots\ldots\ldots\ (v)$$

Here eq (v) shows the Au = total verified images and An = total number of analysis images.

- *Time consumption:*

It represents as the time reserved to consume all the verified analysis images (Facial and Iris).

$$TC = \frac{T_{X} * N_{J}}{T_S} \ \ldots\ldots\ldots\ldots\ (vi)$$

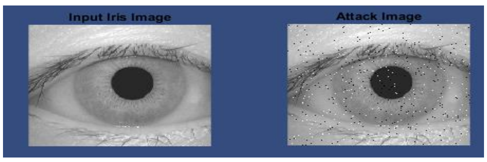
Here eq (vi) defines the Tx* Nj= time reserved, and Ts = time consumed all the verified analysis images.

4.2 Result Analysis

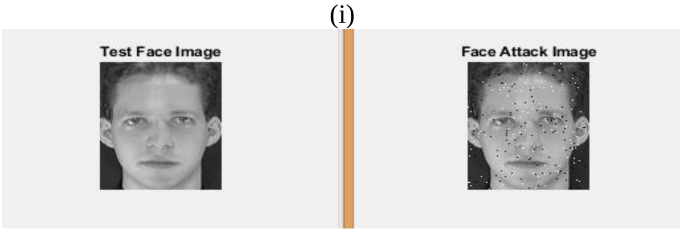
The multimodal biometric system training sections are defined in below fig 7. This section shows to train the multiple images at one time. Applied the multimodal biometric system image pre-processing steps:

(i) attack noise
(ii) filter image
(iii) edge detection image
(iv) black and white image
(v) eye circle point calculated etc.

After that, this procedure developed the feature extraction method, select the FVs, fused the MMB system traits, and classification the biometric traits.



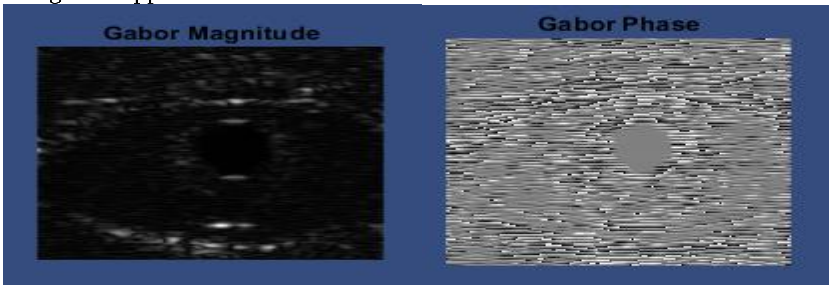
(i)



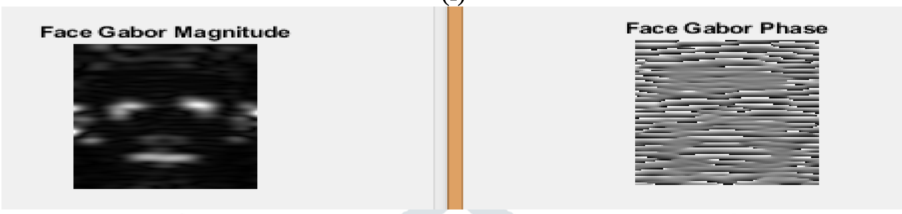
(ii)

Figure 7 (i) Iris Input and Attack Image (ii) Face Input and Attack image

The above figure 7 (i) and (ii) shows the MMB (Facial and Iris) traits. Initially, upload the data set images and add the artificial noise in the input images. The artificial noise is used by salt & pepper noise. This type of noise may be caused by severe and unexpected interferences in the signal of the image. It defines itself as sporadically showing W & B image pixels. An efficient attack noise mitigation approach for this noise is a Gabor Filter.



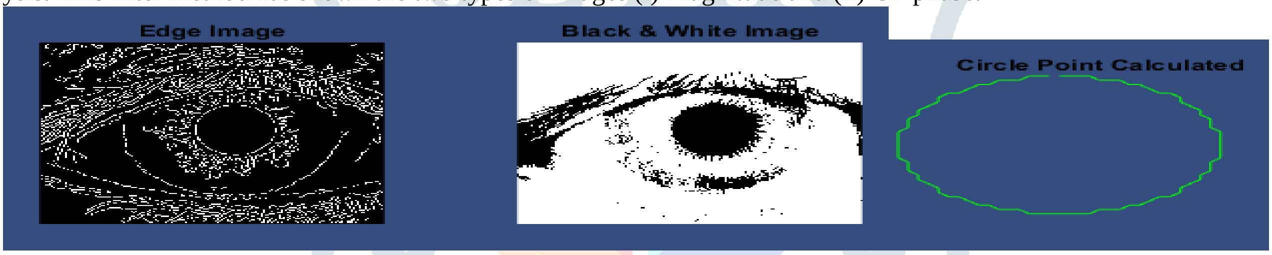
(i)



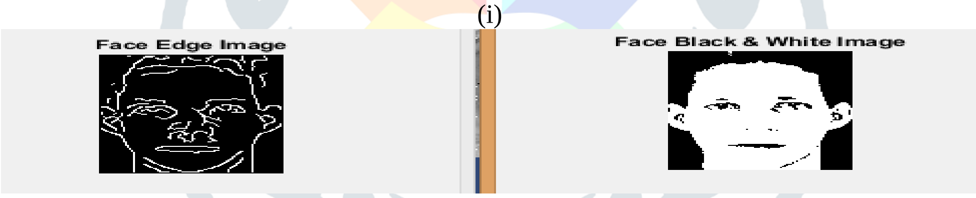
(ii)

Figure 8 (i) Iris and (ii) Facial Gabor Filter Image (i) Magnitude and (ii) Phase

Above figure 8 (i) and (ii) represents the MBB (facial and iris) traits. After the noise image, applied the filtration method using GF (Gabor filter). It is LF (linear filter) used for TA (text analysis) that significantly means i.e., analyses whether there is an SFC (specific frequency content) in the image in a particular angle or directions in an LR (localized region) around the area of analysis. This filter method has shown the two types of images (i) Magnitude and (ii) GF phase.



(i)



(ii)

Figure 9 (i) Iris and (ii) Facial Image: Edge Detection, Black & White Image and Circle Point Calculated.

The above figure 9 (i) and (ii) shows the MMB (facial and iris) traits. It represents the edge detection image and B & W image. The edges are normally one of the significant characteristics in a structure, and may give be utilized for calculations after suitable ED (edge detection) has been implemented and detected a world-wide range of edges in the images. It converts the gray scale image into B & W image. It gives the method with a phase of thresholding otherwise the DV (default value) is considered as 0.5.

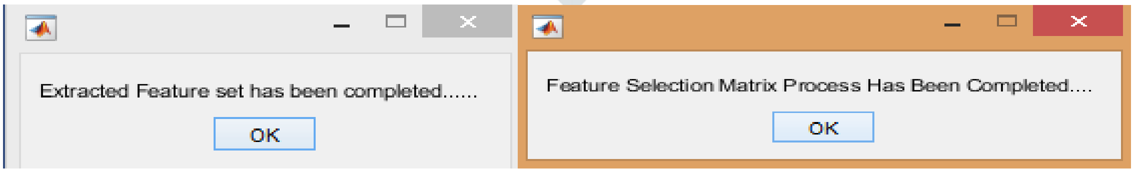


Figure 10 Feature Extraction and Selection Feature Vectors

The above message box represents the feature extraction and selection FVs. The proposed model has used the feature extraction algorithm (KPCA). KPCA is an NL (non-linear) principal component analysis approach that depends on KFs (kernel functions) that develop NL mapping from the input space to the FS (feature space) by an NL transformation. It extracts the unique feature vectors in the form of Eigen Values and Vectors. After this extraction process, this proposed system has implemented an ALO algorithm to select the FVs with the help of FF (fitness function). ALO algorithm is a novel swarm-based MHA (Meta-heuristic algorithm). It selects the filtered feature sets and passes them into the classifier.

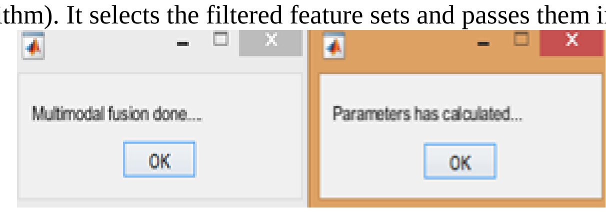


Figure 11 Multimodal Fusion Authentication Process Completed

The above figure 11 represents the multimodal biometric fusion process that has been completed by the SLF method. If the train feature score is compared with the test feature score is true then the identification process has completed otherwise identification process failure.

4.3 Comparative Analysis

Figure 12 presents recognition rate. It defines that the AL-CNN proposed method attained normal range of recognition rate. It defines the comparison between different methods such as AL-CNN and FK-NN algorithms. With the smaller difference in between existing FK-NN search, the proposed AL-CNN algorithm provides a high performance rate in classification and all other metrics. The existing FK-NN method consumed high range of recognition rate in all the traits with less performance metrics as compared to proposed (AL-CNN) algorithm.

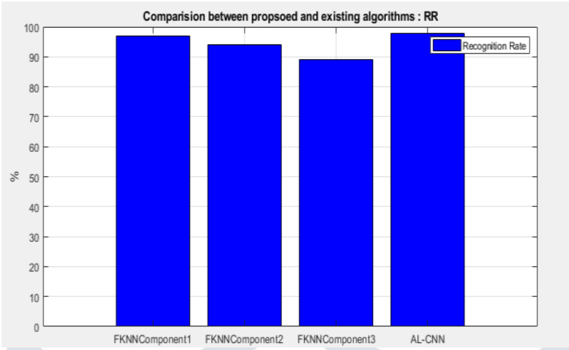


Figure 12. Comparison between proposed (AL-CNN) with existing (FK-NN) Model: Recognition Rate (%)

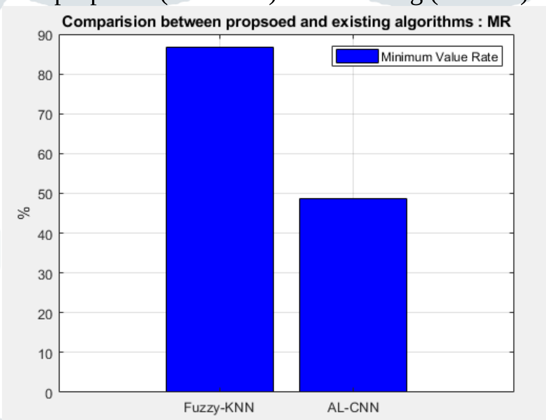


Figure 13 Comparison between proposed (AL-CNN) with existing (FK-NN) Model: Minimum Values

Fig 13 represents the comparison analysis of the AL-CNN, and FK-NN algorithms calculated in the form of the minimum value, which must be low. When the minimum value is less than the system can identify or classify the early errors during the classification rates to MMBS system. It also minimized the varieties between the classification rates of the traits of the multimodal biometric system.

Below figure 14 defines the comparison analysis with proposed model, and FK-NN algorithm approach in the form of maximum value rate, which must be high as compared to other techniques. It also maximizes the varieties between the classification rates of the traits of the multimodal biometric system.

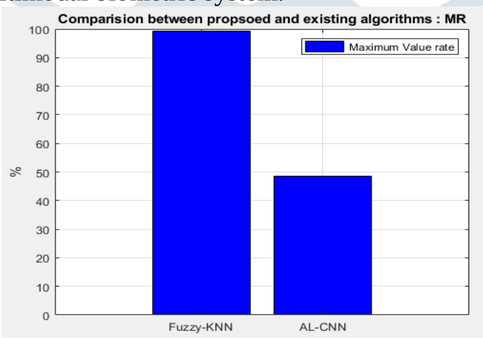


Figure 14 Comparison between proposed (AL-CNN) with existing (FK-NN) Model: Maximum Values

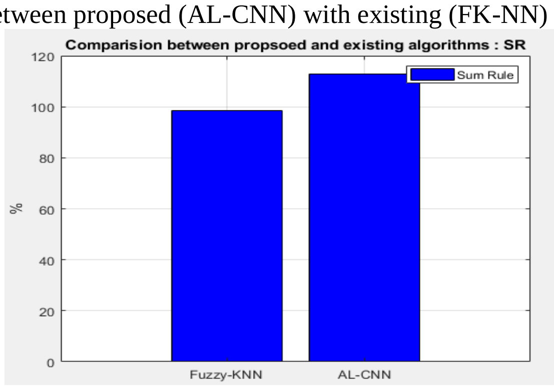


Figure 15 Comparison between proposed (AL-CNN) with existing (FK-NN) Model: Sum Rule

Figure 15 defines the comparison between proposed AL-CNN, and FK-NN algorithm in the form of Sum values, which is one of the important performance metrics. The SUM value must be maximized and is useful in the form of stability to perform the classification of the MMB system. The median calculation is significant to signify, how much maximum traits is required for each MMB during the classification procedure.

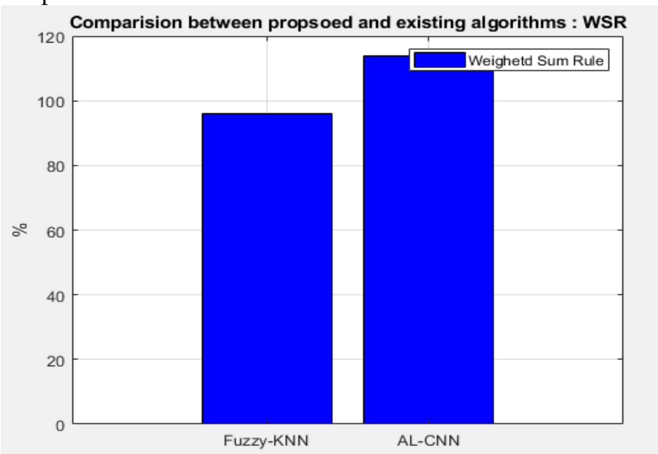


Figure 16 Comparison between proposed (AL-CNN) with existing (FK-NN) Model: Weighted Sum Rule

Figure 16 defines the comparison between proposed AL-CNN, and FK-NN algorithm in the form of weighted sum values, which is one of the important performance metrics. The WEIGHTED SUM value must be maximized and is useful in the form of stability to perform the classification of the MMB system. The median calculation is significant to signify, how much maximum traits is required for each MMB during the classification procedure.

Table 2 Performance Metrics with Comparison Analysis (AL-CNN and FK-NN)

Metrics	**AL-CNN Model**	**FK-CNN**
Min Value	48.62	86.66
Max	114.73	99.3
Sum Rule	112.3	98.5
Weighted Sum Rule	113.73	96
Time consumption (sec)	1.29	-

Table 3 Comparison- (Recognition Rate)

Metrics	**AL-CNN Model**	**FK-CNN comp1**	**FK-NN comp2**	**FK-CNN comp3**
Recognition Rate (%)	97.7 ~ 98 %	97	94	89

Table 2 and 3 shows the comparative analysis with proposed AL-CNN and FK-CNN methods. It improves the recognition and time consumption rate.

V. CONCLUSION AND FUTURE SCOPE

This research explains efficient iris-facial MMB system, which has attractively minimum complexity and aiming at different and valuable feature sets. MMB denotes various BTs (biometric traits) utilized together at a particular phase of fusion to identify users. The iris-facial characteristics are extracted by the image multi-resolution GF (Gabor filter) for withdrawing the attacks in the given image and then filter the image pixels. KPCA algorithm has developed a non-linear method to mitigate the HD (high dimensionality) of the extracted FSs (feature sets). PCA is a linear format approach i.e., it may only be functional to databases that are linear division. KPCA method utilizes a KF (kernel method) to database into an HD (high dimensional) FS (feature space), where it is linear separately. It is the same as the aim of the classification model. It extracts the unique feature vectors in the term of matrices (rows and columns). This method calculated the HD of extracted features; it resolves the existing issues and improved the identification rate of the multimodal biometric system. The research system operates in verification and authentication module, in which the FVs (feature vectors) are equated to save the feature, sets in the data set for individual biometric trait during the enrollment phase. Between the most important novel ant-CNN models used for classification. It searches the ALO algorithm to select the extracted feature sets; though, this proposed work implemented and improved the ant lion optimization with the convolutional neural network for the MMB structure for the classification or identification module. This research work has combined a facial dataset FERET and Iris data set CASIA v3 to build a MMB experimental data set with which it validates the proposed method (AL-CNN) and evaluates the MMB system performance. The simulation result analysis defines the MMB identification as much more accurate and reliable than UMBS (unimodal biometric system) method. It calculated the proposed model attains an enhancement (up to 97.7 % and 1.2 sec in terms of recognition rate and time consumption) compared with the existing methods.

The upcoming improvements will describe as follows: (i) It can plan to search the DL (deep learning) for taking out the HL (high-level) depictions of the information that will be merged with novel ML (machine learning) for calculating the helpful characteristics. (ii) It will design merged novel optimization algorithms to extract the HL (high level) dimensional data to compute the performance metrics.

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