A lot of work has been done on combining different biometrics by different researchers for a variety of purposes; it has been focused on the combination of fingerprint and iris of same persons, which are two of the characteristics that can reach the best recognition performance for high security applications. Fingerprint recognition is the most consistent biometric modality in use. Iris is an externally visible yet protected organ whose unique pattern remains stable throughout life. To overcome some of the problems of Unimodal biometrics, multimodal biometric systems are used. Multimodal biometrics fusion techniques have attracted increasing attention and interest among researchers, due to improved recognition compared to unimodal biometric systems, as multimodal systems provide multiple pieces of evidence of the same identity.

Ashwini R. Patil, Mukesh A. Zaveri in, “A Novel Approach for Fingerprint Matching using Minutiae” have proposed effective fingerprint matching algorithm based on feature extraction. For minutia marking they considered one special false minutiae removal method [1]. Chandra Bhan Pal, Amit Kumar Singh, Nitin, Amrit Kumar Agrawal in “An Efficient Multi Fingerprint Verification System Using Minutiae Extraction Technique” has combined many methods to build a minutia extractor and a minutia matcher [2]. H B Kekre and V A Bharadi in “Fingerprint Core Point Detection Algorithm Using Orientation Field Based Multiple Features” have used Correlation based Fingerprint Recognition rather than detecting minutiae [3]. Mary Lourde R and Dushyant Khosla in “Fingerprint Identification in Biometric Security Systems” proposed the issue of selection of an optimal algorithm for fingerprint matching in order to design a system that matches required specifications in performance and accuracy [4]. Chomtip Pornpanomchai Apiradee Phaisitkulwiwat in, “Fingerprint recognition by Euclidean Distance” proposed the fingerprint recognition by euclidean distance method [5].

G. Sambasiva Rao proposed fingerprint identification technique using a gray level watershed method to find out the ridges present on a fingerprint image by
directly scanned fingerprints or inked impression [6]. Robert Hastings developed a method for enhancing the ridge pattern by using a process of oriented diffusion by adaptation of anisotropic diffusion to smooth the image in the direction parallel to the ridge flow. Jinwei Gu proposed a method for fingerprint verification which includes both minutiae and model based orientation field is used [7]. V. Vijaya Kumari and N. Suriyanarayanan proposed a method for performance measure of local operators in fingerprint by detecting the edges of fingerprint images using five local operators namely Sobel, Roberts, Prewitt, Canny and LoG [8]. The edge detected image is further segmented to extract individual segments from the image. Raju Sonavane, and B.S. Sawant presented a method by introducing a special domain fingerprint enhancement method which decomposes the fingerprint image into a set of filtered images then orientation field is estimated [9]. Eric P. Kukula, purposed a method to investigate the effect of five different force levels on fingerprint matching performance, image quality scores, and minutiae count between optical and capacitance fingerprint sensors [10].

M. R. Girgisa proposed a method to describe a fingerprint matching based on lines extraction and graph matching principles by adopting a hybrid scheme which consists of a genetic algorithm phase and a local search phase [11]. Prabhakar S, Jain. A.K. has developed filter-based representation technique for fingerprint identification [12]. The technique exploits both local and global characteristics in a fingerprint to make identification. Each fingerprint image is filtered in a number of directions and a 640-dimensinal feature vector is extracted in the central region of the fingerprint. The feature vector is compact and requires only 640 bytes. The matching stage computes the Euclidian distance between the template finger code and the input finger code. The method gives good matching with high accuracy. Ballan M introduced Directional Fingerprint Processing using fingerprint smoothing, classification and identification based on the singular points (delta and core points) obtained from the directional histograms of a fingerprint [13].

Most of the proposed neural network approaches are based on multilayer perceptrons and use the elements of the orientation image as input features [14], Kamijo, Mieno, and Kojima [15], and Pal and Mitra [16]). C. Park, M. Ki, J. Namkung, and J.K. Paik suggested that introducing momentum backpropagation ANN improves the accuracy
[17]. B. Jayaraman, C. Puttamadappa, E. Anbalagan, E Mohan and Srinivasrao madane suggested back propagation algorithm to obtain higher accuracy in fingerprint recognition. They implemented ANN after minutiae filtering step and back propagated in to the network, until the desired performance of the authentication mechanism [18]. The extraction of relevant features of a pattern is not a trivial task. For the particular case of the feature extraction from fingerprint images several approaches have been developed, most of them based on special characteristics from the fingerprint patterns, such as ridge orientation and minutia detection [19-20]. A Karhunen-Loève transform of the ridge orientation pattern of fingerprints was used in [21] to obtain feature vectors, which were used as inputs to statistical and neural networks classifiers.

Minutiae fingerprint classification system using neural network [22], four-layered neural network for fingerprint classification rate upto 99.0% [23], minutiae extraction from fingerprint skeleton using neural network is trained to work as a classifier [24]. The possibility for the eye- based human identification was originally suggested by Alphonse Bertillon[25] and subsequently pointed out by several others[26], the first method was published and patented by Daugman[27]. Daugman [28-29] used integro-differentio operator to localize the iris followed by 2D Gabor filters and phase coding to obtain feature vector. Wildes [30] used Circular Hough transform for iris localization, and then constructed laplacian pyramid at four different resolutions to compute the texture feature. Finally, normalized correlation is used for authentication purposes. Lim etal. [31] exploited 2-D Harr wavelet transform to extract iris features and implemented the classifier using a modified version of competitive learning neural network. In [32], 1-D wavelet transform up to four levels was used to characterize the spatial variation so the iris, and then the features are matched using dissimilarity functions. Wei [33] is probably the first authors to analyze three iris image properties to detect a patterned contact lens: image sharpness, Gabor-based filtering and second-order iris region statistics. The authors report good performance for the latter two approaches (98.3% and 100% of correct recognition rate, correspondingly), although admitting their high dependency on the printed contact lens pattern type. Chaudhary and Mubarak [34] described the use of BPNN in iris patterns classification.
Saminathan [35] presented a simple method for preprocessing pairs of iris images by taking both left and right eyes of a human rather than either the right or left eye. They presented the design and training of feed forward ANN for the iris recognition system. Harun N. [36] proposed performance of keystroke biometrics authentication system using Multilayer Perceptron neural network (MLP NN).

In particular during the previous 2 years [37-40], feature level fusion has become the center of attraction for the researchers and earlier results have also demonstrated that feature level fusion has achieved better performance as compared with match score level fusion. F. Alsaade [41] proposed an enhancement of multimodal biometric verification using a combination of fusion methods. YaghoubI Z. [42] put forth multimodal biometric recognition inspired by visual cortex and support vector machine classifier. Harun N. [43] proposed performance of keystroke biometrics authentication system using Multilayer Perceptron neural network (MLP NN). Ross and Govindarajan [44] proposed a method for the fusion of hand and face biometrics at feature extraction level. Jain and Ross [45] improved the performance of a multimodal biometric system by learning user-specific parameters.

SVM is a pattern classification algorithm developed by Vapnik and Cortes [46] based on statistical learning theory. SVM has many advantages in solving small classification samples which are nonlinear and also high dimensional problems in pattern recognition.

A number of bio-crypto algorithms have been proposed but they have a bounded practical usage due to the trade-off between recognition performance and security of the template. This involves the improved recognition performance as well as the security of a fingerprint based biometric cryptosystem, called fingerprint fuzzy vault. Minutiae descriptors capture the orientation and frequency information in a minutia’s neighbourhood, in the vault construction using the fuzzy commitment approach. Hence as a result, the fingerprint matching performance is improved with some improvement in security as well with the use of minutiae descriptors.

Zhifang Wang, Erfu Wang, Shuangshuang Wang and Qun Ding [47] proposed multimodal biometric algorithm for face and iris. Firstly the features of face are extracted using eigenface method and then features of iris are extracted using 2D even
Gabor filter. Z score normalization was used to eliminate the difference of the order of magnitude and the distribution between face features and iris features. The normalized features are combined in series and take Euclidean distance as a classifier. Their experiments show that the algorithm proposed improves the performance of two unimodal biometrics combined. Yuliang He, Jie Tian, Xiping Luo, Tang hui Zhang [48] proposed an algorithm for fingerprint enhancement based on orientation fields. Three aspects were considered: introduction of ridge information into the minutiae matching process in a simple but effective way; Use of variable size bounding box and the use of simple alignment method. K.Geetha and V.Radhakrishnan [49] discussed various issues related to multimodal biometric system. Using the various Biometric traits in conjunction improves the system performance. Fingerprints and palm prints are used here. Features are extracted from them and then they are fused together. Classification of the fused features are done using support vector machine (SVM). In [50], Hollingsworth proposed performing a simple averaging of the normalized iris images extracted from the video in order to match NIR videos against NIR videos from the MBGC database [51]. When compared to a fusion of scores, the results are similar but with a reduced complexity. Jillela in [52] explored the fusion in the feature domain using Principal Components Transform (PCT). Their approach uses the availability of multiple image frames of the same iris from MBGC to extract discriminatory information.

In literature lot of approaches at rank level are proposed such as AND and OR rules [53], Majority voting [54], weighted majority rule [55], Bayesian decision [56]. Fingerprint Verification Competition Databases (FVC). The first, second and third international competitions on fingerprint verification (FVC2000, FVC2002 and FVC2004) were organized in 2000, 2002 and 2004, respectively. These events received great attention both from academic and industrial biometric communities. They established a common benchmark, allowing developers to unambiguously compare their algorithms, and provided an overview of the state-of-the-art in fingerprint recognition. Based on the response of the biometrics community, FVC2000, FVC2002 and FVC2004 were undoubtedly successful initiatives. Four distinct databases, provided by the organizers, constitute the benchmark: DB1, DB2, DB3 and DB4. Each database is 150 fingers wide and 12 samples per finger in depth (1800 fingerprint images). Each database
is partitioned in two disjoint subsets A and B. Subsets DB1-A, DB2-A, DB3-A and DB4-A, which contains the first 140 fingers (1680 images) of DB1, DB2, DB3 and DB4, respectively, are used for the algorithm performance evaluation. Subsets DB1-B, DB2-B, DB3-B and DB4-B, containing the last 10 fingers (120 images) of DB1, DB2, DB3 and DB4, respectively, will be made available to the participants as a development set to allow parameter tuning before the submission. During performance evaluation, fingerprints belonging to the same database will be matched against each other. The image format is BMP 256 gray-levels, uncompressed. The image size and resolution vary depending on the database [57-58].

Iris recognition has been an active research topic of the Institute of Automation from the Chinese Academy of Sciences. Having concluded about a lack of iris data for algorithm testing, they developed the CASIA image database. CASIA iris image database [59] (version 1.0, the only one that we had access to) includes 756 iris images from 108 eyes, hence 108 classes. For each eye, 7 images are captured in two sessions, where three samples are collected in the first and four in the second session. Similarly to the above described database, its images were captured within a highly constrained capturing environment, which conditioned the characteristics of the resultant images. They present very close and homogeneous characteristics and their noise factors are exclusively related with iris obstructions by eyelids and eyelashes. Moreover, the post process of the images filled the pupil regions with black pixels, which some authors used to facilitate the segmentation task. So, this significantly decreased the utility of the database in the evaluation of robust iris recognition methods.

The CASIA Version 3 database [60] contains 22 051 iris images pertaining to more than 1600 classes. The images have been captured using different imaging setup. The quality of images present in the database also varies from high-quality images with extremely clear iris textural details to images with nonlinear deformation due to variations in visible illumination. Unlike CASIA Version 1, where artificially manipulated images were present, CASIA Version 3 contains original unmasked images.

The Multimedia University has developed a small data set of 450 iris images (MMU) [61-62]. They were captured through one of the most common iris
recognition cameras presently functioning (LG Iris Access 2200). This is a semi-automated camera that operates at the range of 7-25 cm. Further, a new data set (MMU2) comprised of 995 iris images has been released and another common iris recognition camera (Panasonic BM-ET100US Authenticam) was used. The iris images are from 100 volunteers with different ages and nationalities. They come from Asia, Middle East, Africa and Europe and each of them contributed with five iris images from each eye. Obviously, the images are highly homogeneous and their noise factors are exclusively related with small iris obstructions by eyelids and eyelashes.

**Summary:**

Different aspects that are explicit in this chapter are problem formation, data collection, data evaluation analysis and interpretation, previous used methods and result obtain with existing research. This chapter finding the literature review as a part of research framework. This literature review is written as part of summarized information of existing related work. We reviewed previous work on:

1. Biometric System.
2. Multimodal Biometric System.
3. Fingerprint Recognition system using Neural Network.
4. Iris Recognition system using Neural Network.
5. Multimodal biometric system using Fingerprint & Iris modality using Neural Network.

With this review we define the research problem, inquire about the new lines of analysis and track the support for standards for development of Fingerprint & Iris multimodal biometric system using neural network. This chapter finds the limitations of the previous research that helps us to establish advances research work in the field of multimodal biometric.

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