Chapter

Introductory Chapter: On Fingerprint Recognition

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1. Introduction

The biometric phrase means life measurement in the Greek language [1]. That is any technique used for measuring biological information for recognition goals called biometric. There are various kinds of biometrics being used, these include Fingerprint, Face, Speaker/Voice, Infrared thermogram (facial, hand or hand vein), Gait, Keystroke, Odor, Ear, Hand geometry, Retina, Iris, Palmprint, Signature, DNA, Knuckle crease, Brain/EEG, Heart sound/ECG. Defining humans using biometric can even be behavioral or physiological biometrics. The difference between them is that behavioral biometric can be affected with the progress of the time such as signature, gait, speech, and keystroke but the physiological biometric are constant during human life. Fingerprint, face, iris, and palmprints are examples of physiological biometric [2]. A Biometric system is reliable because it cannot be stolen, borrow, bought, or forgotten like a password or ID [3].

The fingerprint is a physical biometric aspect. It is used to identify a person's identity due to its uniqueness where no two persons can share the same fingerprint. Besides, a fingerprint is unchangeable with time and can be easily recognized during the whole life of the individual. The fingerprint is an impression or model of ribs and valleys at the top of a person's fingers. **Figure 1** shows a fingerprint pattern. Fingerprint recognition is the automatic prosses of comparing saved fingerprint pattern with the input fingerprint to determine human characters. Although fingerprint recognition was deployed from decade it became one of the most common biometric nowadays. The fingerprint identification system is a cheap but solid mechanism at the same time. Moreover, it's a simple way to identify humans speedily and accurately [4]. Many applications applied fingerprint recognition such as the military, judiciary, health, teaching, civic serving, mobiles and laptop log-in, and many more. Modern techniques and approaches are used recently as a substituted of old ink to capture the fingerprint. These technologies differ

Figure 1.
A fingerprint model.

in terms of accuracy, effectiveness, speed, advantages, and challenges [5]. This chapter discusses, compares and analyses several authors work [1–27] regarding the fingerprint recognition.

The remaining of the chapter is organized as follows. Section 2 is an overview of the literature survey with comparative research. Section 3 deals with a detailed analytical study of the literature review. At last, future directions, recommendations, and conclusion are presented in Section 4.

2. Literature survey

Fingerprint recognition is the procedure of comparing known and unknown fingerprints to prove that the it is from the same person or not [8]. Today, many approaches, techniques, and systems are used to match fingerprints and solve related problems. This section is focused on analyzing and categorizing different author's work in the fingerprint recognition area. **Table 1** provides a summary of various papers in the current literature. First column determines the Reference of the papers by author names and year of publication. Second column gives the summary of the work in the corresponding paper, and the third column describes the implemented approaches used to solve fingerprint recognition issues. The author names and the year of publication will be used as an identifier for the rest of the tables in the chapter showing other details of the referred literature.

Reference	Brief summary	Approaches adopted
[8]	Explains different biometrics structures that are used for certification and recognition purpose with submitting their advantages and disadvantages.	• Knowledge-based approach • Token based approach • Biometric based approach
[4]	A general explanation of various types of fingerprint recognition systems and patterns depending on the minute-based technique. Focused on Pattern recognition, wavelet, and wave atom mechanisms. Complications related to the wave atom method are studied.	• Histogram Equalization • Band pass Filtering • Gabor Filtering • Binarization and Thinning • 2D Fourier Transform • Wavelet based Transformation • Wave atom Transform and MCS optimization algorithm
[20]	Explains the differences between various fingerprint matching techniques particularly local minutiae-based matching algorithms. It provides an experiment about fingerprint identification and authentication using the minutiae-based matching method with analyzing the outcomes.	• topology of local structure • type of consolidation • usage of additional features • minutiae peculiarities • parameter learning.
[23]	Discuses fingerprint authentication using minutiae extraction technique and covering all related systems and processes.	• Load image • Histogram Equalization • Fast Fourier Transformation • Binarization • Region of Interest • Thinning • Minutiae Extraction • False Minutiae Removal

Reference	Brief summary	Approaches adopted
[21]	Beneficent of minutiae-based fingerprint verification system by suggesting a route for the feature extraction step which depends on reexamining the gray-scale profile can increase the matching performance by 4%. Also, the proposed feature refinement step that allocates class labels for every 31qmintiae will improve the performance by 3%. Both steps will develop the whole fingerprint verification system be 8%.	Sequential approach
[18]	Execution and assessment of Biometric Image Software (NBIS) for fingerprint recognition developed by the National Institute of Standards and Technology (NIST). the NBIS is implemented in the MATLAB environment.	• Pre-processing • Minutiae Extraction • Post processing
[17]	Design minutia extractor by using different techniques. Some improvements in the thinning, false removal approach, and image segmentation is implemented in the work.	• Segmentation using Morphological operations • Thinning • False minutiae removal methods • Minutia marking • Minutia unification by decompose-ng a branch into three termination • Matching in the unified x-y coordinate system
[24]	Combining minutia and correlation-based approaches to evolve an automatic fingerprint recognition system. By using this hybrid, the performance of the minutiae algorithm is grown.	• Minutiae Extraction • Post-processing • Minutiae Matching • Filtering • Feature Vector
[2]	Present Fingerprint Recognition using the Minutia Score Matching method (FRMSM). It implements Block Filter for fingerprint thinning. Also, it compares with available algorithms.	• Thinning • Image binarizing • Noise removal
[1]	A summary of several biometrics techniques as well as explaining the unimodal and multimodal with their pros and cons.	• Sensor module • Matching module • Decision-making module • Feature extraction module
[3]	Explaining some biometrics and dividing them to currently in use biometrics, limited used biometrics, and understudy biometrics.	Fusion scheme
[15]	An alignment-based minutia-matching algorithm has been developed to increase the speed and accuracy by ability determining the matches between input minutiae and Stord one without the need for detailed study. Michigan State University and the National Institute of Standards and Technology NIST 9 fingerprint databases have been used. The result shows that the full verification process takes 1.4 seconds a Sun ULTRA 1 workstation.	Alignment-based minutiae-matching algorithm

Reference	Brief summary	Approaches adopted
[22]	Applying fingerprint identification by employing a gray level watershed process to find out the ridges present on a specific fingerprint image. The result display that this system is accurate and fast when matching 7 images in the database.	• Image acquisition • Preprocessing • Minutiae detection • Minutiae reduction • Fingerprint matching
[26]	Discussing fingerprint recognition biometric in detail and explaining deferent types of algorithms like negative Laplace filter and the non-stationary analysis, and a flexible algorithm with calculating the matching test results.	• Image acquisition • Preprocess-ng • Segmental-on • Minutia detection • Biometric matching
[10]	Developing a novel algorithm for fingerprint matching based on local structures to elicit neighboring minutiae features effectively. The presented algorithm is tested on FVC2002 and the results show the reliability of the system.	Novel topology-based representation technique
[9]	Mixing the density map matching with minutiae-based matching where the density data can be used in the matching process to reduce extra storing cost. The outcomes approved that combining both approaches will improve performance.	• Region estimation • Orientation filed estimation • Fingerprint enhancement • Coarse density map extraction • Weighted polynomial approximation
[12]	An adequate wat to press the template size with a reduction ratio of 94% by applying tow reduction algorithms the Column Principal Component Analysis and the Line Discrete Fourier Transform feature reductions. Also, a fast minutiae-based matching algorithm can be accomplished throw spectral minutiae fingerprint recognition system which shows matching speed with 125000 comparisons per second on a PC with Intel Pentium D processor 2.80 GHz and 1 GB of RAM.	• Column Principal Component Analysis (Column-PCA) • Line Discrete Fourier Transform (Line- DFT)
[25]	Novel core point detection method that uses the detection algorithm to examine the core point and determine local frame for minutiae close to it. Then tow fingerprint corresponding points will be earned and used to match the global class then make the final diction.	Core-based structure matching algorithm
[7]	New topology-based algorithms to match fingerprint and address the local matching, tolerance to deformation, and global matching. The experiment outcomes approve that time and performance is improved using the algorithm.	Topology-matching algorithm
[16]	Provide a hybrid matching algorithm that matches fingerprints using minutiae inputs and texture inputs together. The matching performance improved when testing 2560 images by collecting both texture-based and minutiae-based matching scores.	hybrid matching approach (minutiae-based representation with a texture-based representation)
[19]	Suggesting ridge feature-based approach for fingerprint recognition that provides good results for low-quality fingerprint images. Matching fingerprint images based on ridgeline features extracted by using contextual filtering and two pass thinning. Histogram approach is used to match the fingerprint. The experiments show how the performance developed using this approach.	• Contextual filter • Single pass thinning algorithm • Image preprocess • Gabor filtering

Reference	Brief summary	Approaches adopted
[13]	Novel enhancement algorithm that split the input fingerprint image to set of filtered images which will help in producing orientation field and quality mask. The evaluation process of the algorithm is done on an online fingerprint verification system using the MSU fingerprint database that consists of 600 fingerprint images and the test demonstrates that the enhancement algorithm improves the performance of the online fingerprint verification system.	• Gabor filters • Ridge extraction algorithm • Voting algorithm • Orientation estimation algorithm
[14]	Submit a fingerprint recognition algorithm depending on phase-based image matching. Which uses the phase components in 2D (two-dimensional) discrete Fourier transforms of fingerprint images to reach strong fingerprint recognition with a low-quality fingerprint. The test used a group of fingerprint images captured from fingertips with a bad case. The results show an effective recognition performance using this approach.	2D (two-dimensional) Fourier transforms
[6]	The correlation-based fingerprint verification system uses the richer gray-scale information of the fingerprints. In the beginning, the system chooses appropriate templates in the primary fingerprint, employs template matching to locate them in the secondary print, and match the template positions of both fingerprints. The test describes the performance of correlation-based fingerprint against other systems.	• Classification of template positions • Elementary decisions • Combining elementary decisions
[5]	A brief summary of fingerprint matching techniques, systems, and performance evaluation.	• Image capturing module • Feature extraction module • Pattern matching module
[11]	It provides important aspects of fingerprint recognition. As biometric pattern, it highlights a detailed analysis on the fingerprint conceptualization. It uses various tools to find the match percentage in the verification process.	• Negative Laplace filter • Non-stationary analysis of the short time Fourier transform • An algorithm to find the match percentage in the verification process.
[27]	This presents a fast fingerprint enhancement algorithm, which can adaptively improve the clarity of ridge and valley structures of input fingerprint images based on the estimated local ridge orientation and frequency.	• Goodness index of the extracted minutiae • Accuracy of an online fingerprint verification system.

Table 1.
Overview of the literature.

Table 2 shows the accuracy and performance in percentage. It also mentions the identification and verification measures. Identification and verification are matching techniques for fingerprint recognition. In the verification, the person enrolls his fingerprint to the system and the templet stored it in the database. Every time the person accesses the system, he has entered his fingerprint to verify himself. It's a one to one relationship where the input fingerprint is compared with the stored one. On the other hand, identification is one to many relationships because the human fingerprint is matched with the fingerprints database to determine who is that person [8].

Reference	Accuracy (Performance)	Performance measures used for verification	Performance measures used for identification
[8]	_	_	_
[4]	_	FAR, FRR, FMR, FNMR, ERR	Accuracy
[20]	_	FMR, FNMR, EER, ROC, FMR100, FMR1000, Zero FMR	True positive rate (TPR), R100, ZeroR, Cumulative Match Curve (CMC), Accuracy, computational time, rank k
[23]	_	FMR	_
[21]	95% (LVQ-based classifier on training data) 87% (LVQ-based classifier on test data)	FAR, GAR	Classification accuracy,
[18]	_	FNMR, FMR	Reliability and quality
[17]	_	FRR, FAR	Quality and accuracy
[24]	_	FAR	_
[2]	_	FMR, FNMR	_
[1]	_	FMR, FNMR, FTC, FTE	accuracy, speed, resource requirements, acceptability, and circumvention.
[3]	_	_	_
[15]	_	FAR, FRR	Accuracy, speed
	More than 45%	_	Accuracy and testing time.
[26]	_	false acceptance (FA), false rejection (FR), recognition rate (RR)	Accuracy
[10]	_	EER	_
[9]	_	FAR, FRR	Matching time and computation cost
[12]	_	FAR, EER, GAR	Recognition accuracy, matching speed and robustness to poor image quality
[25]	_	FAR, FRR	Matching time
[7]	_	FRR, FAR	Matching accuracy Matching time Computing time
[16]	_	GRA, FAR	Computing time
[19]	98%	EER, FAR, FRR	Matching accuracy
[13]	_	_	Reject Rate Recognition Rate
[14]	_	EER, ZeroFMR, FNMR, FMR	Accuracy
[6]	_	FRR, FAR,FNMR	Testing time
[5]	_	EER, FAR, FRR	_
[11]	_	_	_
[27]	_	_	_

Table 2.
Accuracy and performance.

While the performance measures used for identification depend on the accuracy, recognition rate, rank K, etc., the performance measures for verification are False Match Rate (FMR), False Non-Match Rate (FNMR), False Accept Rate (FAR), False Rejection Rate (FRR), and Equal Error Rate (EER). The researchers in [4] describe the meaning of the authentication parameters. FAR happens when the system recognizes person erroneous. But when the system rejects entry to approve person that means the FRR is happening. FMR is the amount of fraud assessments with threshold value 'T' divided by the total quantity of fraud similarities. FNMR is the quantity with unaffected comparisons with threshold value 'T' divided by the total quantity of open comparisons. Last one is EER, it describes the error rate of the system.

The experimental parts of the author's [1–27] are shown in **Table 3**. It explains the type of applications and kind of Databases used. Then it shows the number of

Reference	Application	Database	No. of identities	Total No. of images	Resolution	Image format
[8]	_	_	_	_	_	_
[4]	Fingerprint	_	_	_	_	_
[20]	Fingerprint	FVC	308	1228	_	_
[23]	Fingerprint	_	_	_	_	_
[21]	Fingerprint	IBM HURSLEY database	269	900	500dpi	_
[18]	Fingerprint	FVC 2000	60	480	_	_
[17]	Fingerprint	_	_	2	_	_
[24]	Fingerprint	Biometric System Lab (University of Bologna - ITALY) Ink and scanner	21 7	168 56	256 × 256 × 256dpi 240× 240× 256dpi	_
[2]	Fingerprint	_	_	_	_	_
[1]	• Fingerprint • Face • Voice • Infrared thermogram (facial, hand or hand vein) • Gait • Keystroke • Odor • Ear • Hand geometry • Retina • Iris • Palmprint • Signature • DNA	FVC2002 FRVT2002 NIST2000	_	_	_	_

Reference	Application	Database	No. of identities	Total No. of images	Resolution	Image format
[3]	• Fingerprint • Face • Iris • Hand geometry • Palmprint • Speaker/voice • Signature • Ear shape • Knuckle crease • Brain/EEG • Heart sound/ ECG	_	_	_	_	_
[15]	Fingerprint	MSU fingerprint data base NIST 9 (card 1) NIST 9 (card 2)	70 1350 1350	700 900 900	640 X 480 832 X 768 832 X 768	_
[22]	Fingerprint	Scanner or inked impression	_	7	250 X 250 pixels	TIF and BMP
[26]	Fingerprint	commercial databases	40	_	300 x 300 512 DPI	_
[10]	Fingerprint	FVC2002	400	3200	_	_
[9]	Fingerprint	THU database FCV2002	827 100	6616 800	320X512	_
[12]	Fingerprint	MCYT FVC2002-DB2	145 40	1740 400	_	_
[25]	Fingerprint	Live fingerprint database	_	8000	300*300	_
[7]	Fingerprint	fingerprint database at University of Bologna, Italy	21	1680	256 × 256	_
[16]	Fingerprint	_	160	2560	_	_
[19]	Fingerprint	NRC FVC2000 database	_	300	200 × 200	_
[13]	Fingerprint	MSU	67	670	640*480	_
[14]	Fingerprint	_	30	330	256 × 384	_
[6]	Fingerprint	FVC2000	110	880	_	_
[5]	Fingerprint	_	_	_	_	_
[11]	Fingerprint	_	_	_	_	_
[27]	Fingerprint	_	_	_	_	_

Table 3.
Overview of the used data.

Reference	Methods used	Reason of application	Advantages	Disadvantages
[8]	_	_	_	_
[4]	• Minutiae based approach • Pattern Recognition Approach • Wavelet based Approaches	• To compare the fingerprint patterns. • The use of patterns for authentication purpose • Used on fingerprint pattern to carry out the verification.	• Great accuracy rate.	• Image with noise or encrypted cannot be used, slow approach and fails to determine real humans. • Not required finger printing or post processing, work in the least three levels of texture split to make the system excellent and its fast process.
[20]	• Minutiae-based local matching • Correlation-based matching techniques • Indexing algorithms	• Comparing tow fingerprints to gain a result of matching or nonmatching. • Calculate the similarities between tow fingerprint images by the correlation within corresponding. • Used when it's important to enter fast to the fingerprint templates for recognition.	• Simple and distortion tolerance. • Simplicity	• Expensive computation, slow and depend on the skin situation.
[23]	Minutiae based matching	Minutia extracted from fingerprint and saved in the database then the matching happened between the stored and input fingerprint.	Widely used and familiar.	Affected with the wet or dry skin.
[21]	minutiae-based fingerprint verification system	• Resolve the gray scale profile in the neighborhood of potential minutiae. • Understand the gray level image properties.	_	_
[18]	Biometric Image Software (NBIS)	Used for fingerprint recognition in MATLAB environment.	_	Time consuming, bad performance for images.
[17]	Minutiae Extraction Technique	Used to reduce distortion for fingerprint matching.	Reduce execution time.	_
[24]	hybrid Automatic Fingerprint Recognition System (Hybrid APRS)	Hybrid between minutiae and correlation-based techniques to represent and match fingerprint.	• Improve each technique individually. • Improve minutia algorithm. • improve the ridge algorithm.	_

Reference	Methods used	Reason of application	Advantages	Disadvantages
[2]	Minutia Score Matching method (FRMSM)	Matching the input fingerprint with the stores fingerprint database.	_	_
[1]	• Unimodal biometric systems • multimodal biometric system	• Using one single biometric feature. • Using various applications to benefit from different types of biometrics advantages	• Reliability due to use the combination of deferent biometric strength.	• Scanned data became noisy. • Varity in the level of difficulty in the data gained from humans. • There may be a lot of similarity in the features sets of the used biometric. • Some individuals may not have the chosen biometric crater. • Biometric sign can expose to forgery.
[3]	• unimodal biometric systems • multimodal biometric system	• Recognition using only one biometric crater. • Recognize person using more than one biometric property.	• Late to progress in the performance.	• Not universal • Can be faceable • Contain many noises • variations within the class. • similarities between the classes
[15]	Automatic identity-authentication system	Use the fingerprint to identify person identity.	Its intended mainly for forensic applications account for approximately $100 million from the world market.	_
[22]	Edge Detection	To find the ridges existed in the fingerprint image	_	_
[26]	Open algorithm system	_	_	_
[10]	Minutiae matching approach	For creating minutiae descriptor	_	_
[9]	Density map matching and minutiae-based matching	Identify the fingerprint ridges denseness and sparseness	• Low storage cost. • major factor for fingerprint representation. • No redundancy between both systems.	_

Reference	Methods used	Reason of application	Advantages	Disadvantages
[12]	Spectral minutiae fingerprint recognition system	Used to represent a minutia set as a fixed-length feature vector	• High speed operations. • Low matching time. • Suitable for large scale fingerprint identification system.	_
[25]	• Structure-based matching algorithms • Core-based matching algorithms	_ _	• More effective algorithm	• Not suitable for online applications and require long time. • Highly depends on core point detection precision
[7]	Minutiae- based matching	For matching the fingerprints to find the similarities between them.	Good matching capability	• The missing minutiae should be considered. • High cost process. • Hard to nonlinear deformations of fingerprints
[16]	Minutiae- based matching algorithms	_	_	Not enough corresponding points in the input images.
[19]	Ridge feature-based approach	Uses the ridges to match two fingers.	• Need little processing. • Increase matching accuracy. • Powerful with low quality fingerprint images.	_
[13]	Online fingerprint verification system.	_	_	• Slow. • Fail to devolve the clarity of ridges structure for good quality fingerprint templet.
[14]	Phase-based image matching	_	Good results when using bad condition fingertips.	_

Reference	Methods used	Reason of application	Advantages	Disadvantages
[6]	Correlation-based fingerprint verification system	To match tow fingerprint depending on gray level fingerprint images.	Work well with bad quality fingerprint image.	_
[5]	• Minutiae-based matching • Pattern matching	_	_	_
[11]	Fingerprint verification system	_	_	_
[27]	• Minutiae-based matching • Pattern matching	Uses the ridges and valley structures of input fingerprint images.	Improves the goodness index and the verification accuracy	_

Table 4.
Applications used with the advantages and disadvantages.

fingertips used to capture the fingerprints databases, the number of images resulted from the fingers, their resolutions and formats. Finally, **Table 4** describes the implemented application type and the reason for using it by mentioning the advantages and disadvantages of the proposed methods.

3. Data analysis

This section analyses the fingerprint recognition data resulting from the literature [1–27] survey in Section 2. In general, fingerprint recognition processes can be done using multiple procedures. First, decompose raw human fingerprint sample to create digit presentation of the same sample. On the next step, preprocessing is done for the raw input image by filtering and improving fingerprint image to produce suitable output image for feature extraction which extracts the unique features of the fingerprint from the digital representation sample. These extracted features are saved in the fingerprint database as features. Final step is to match the input fingerprint with fingerprint template stored in the database to find the similarities. The outcome of these procedures is deciding if the person is identified or not [8]. **Figure 2** describes the sequence of biometric or fingerprint system. The fingerprint procedures involve many different approaches and algorithms that are used to enhance and improve the low quality of fingerprint images. If the fingerprint image is on good quality, then there are no issues and will appear while matching [4]. **Table 1** presents the approaches that are used by different authors. **Figure 3** presents the most used approaches. Different matching approaches are used in 15 papers which can be considered as the commonly used approaches. Then minutiae extraction techniques are used in around 10 papers. Post processing and histogram equalization are used in 2 papers. There are some other approaches used only once in some of the papers.

When the matching process is completed. Correctness of a fingerprint identification system is calculated by applying some parameters. It is used to measure the performance of identification and verification. The performance measures used for identification depend mostly on the accuracy, testing time and image quality. **Figure 4** confirms that 38% of the work used the accuracy as the main identification measure and applied it alone or in addition to other measures. On the other

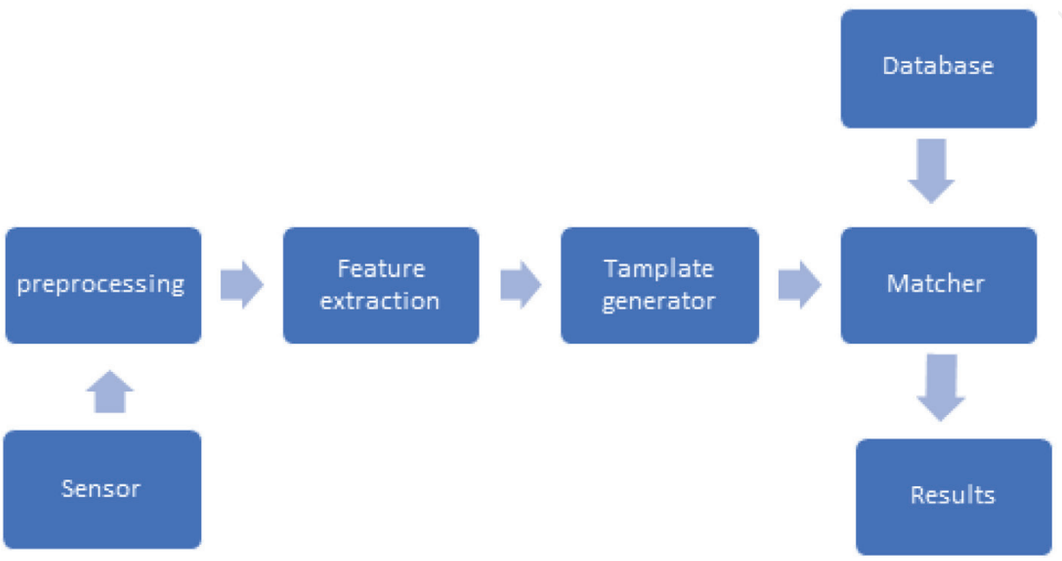

Figure 2.
Biometric or fingerprint system.

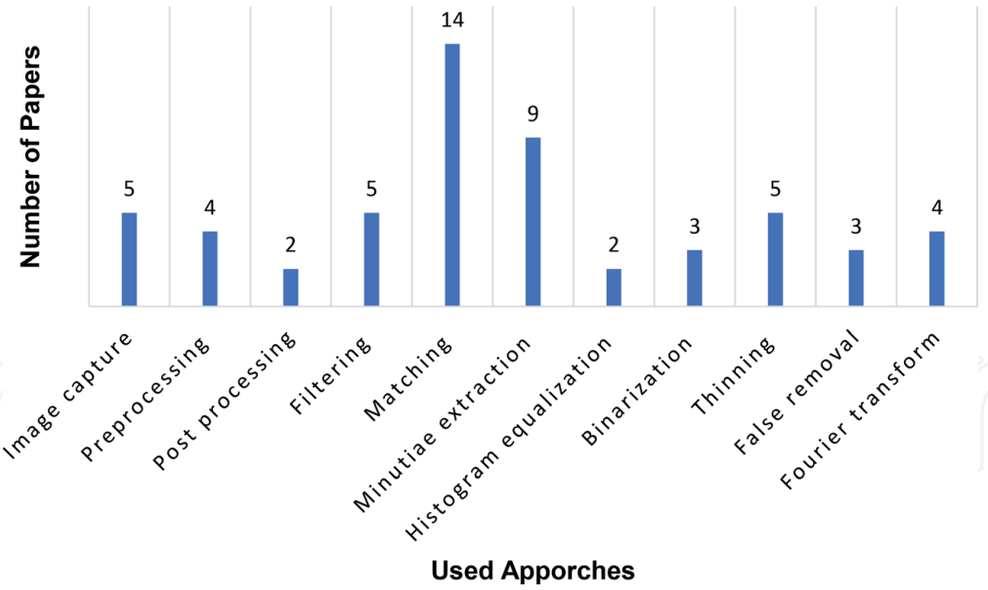

Figure 3.
The most used fingerprint approaches in various papers.

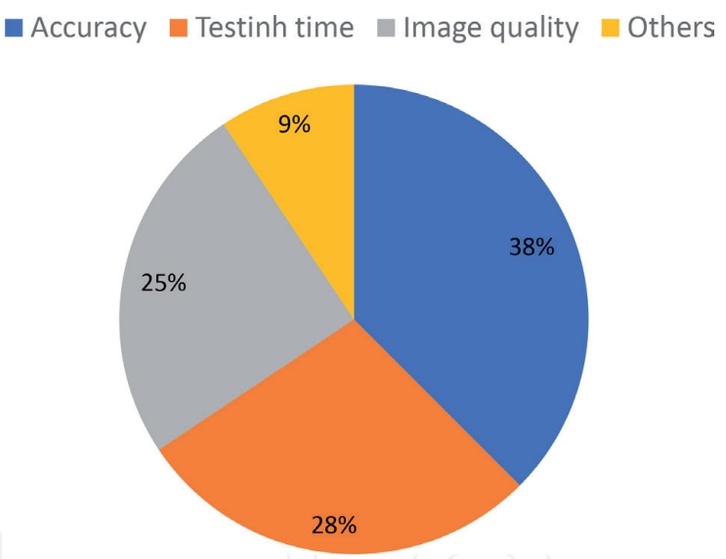

Figure 4.
The identification measures used in the work.

hand, the most applied performance measures for verification are False Match Rate (FMR), False Non-Match Rate (FNMR), False Accept Rate (FAR) and False Rejection Rate (FRR). As shown in **Figure 5**, approximately 36% of the papers rely on (FAR) as a verification measure.

In the fingerprint recognition area, conducting test and experiments is important to approve and evaluate the quality and accuracy of the proposed work. Many different data bases have been used to test the performance of the proposed matching algorithms. These databases vary in their sizes, average number of templets and input fingerprints. **Figure 6** describes the databases types used in the study. As noticed from **Table 3**, FVC2000 and FVC2002 databases are used in some papers but most papers used their own databases. For example, authors in [24] used Biometric System Lab (University of Bologna – Italy). The used databases contain a several number of fingerprints that are used to produce fingerprint images. These images are used in matching step. **Figure 7** shows the discerption of the used databases characteristics by presenting the number of identities and the number of images.

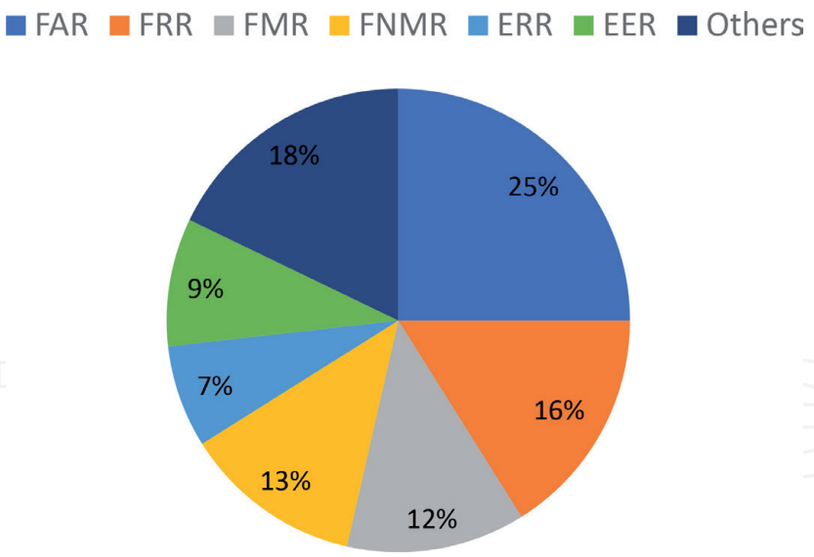

Figure 5.
The verification measures used in the work.

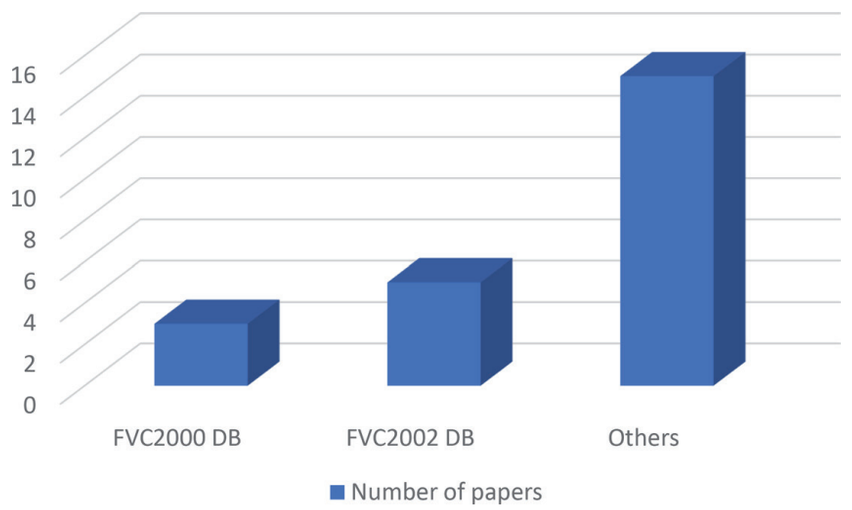

Figure 6.
The used databases in the papers.

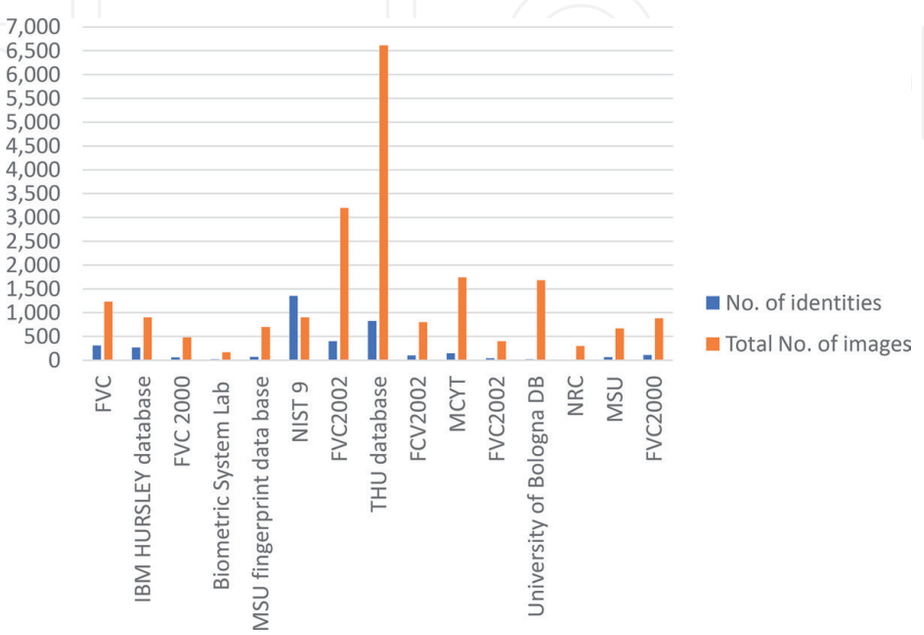

Figure 7.
Used database characteristics.

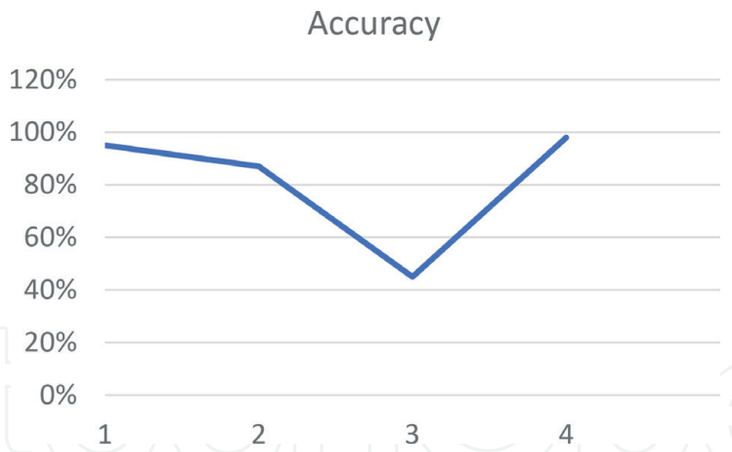

Figure 8.
Accuracy and performance from the used papers.

At last, the evaluation of the performance or accuracy of the fingerprint verification system are appearing in 4 papers as presented in **Figure 8**. The figure shows the highest accuracy with 95% and the lowest accuracy with 45%.

4. Conclusion

Biometrics means the automatic identification of a person based on his behavioral and/or physiological unique characteristics. Fingerprint biometrics is an efficient, safe, cost-effective, easy to use the technique for identity verification. This study provides detailed information related to fingerprint recognition techniques. Several author's works, related to fingerprint recognition technology, are discussed, compared and analyzed. A detailed analysis of various studies is made. As a future work, there is a scope to improve the problems related to fingerprint recognition, specially, the issues related to the capturing row fingerprint by the sensors. One of the innovations is the touchless fingerprint sensor, which will be sufficient for current (COVID-19) situations. It will decree the need to touch the devices. This technique is needed to show its reliability and efficacy as an alternative to regular sensors. Relying on a fingerprint recognition in a different government domains is also recommended. Implementing fingerprint recognition technology is not only useful for Government, but other organizations and communities can also think and may benefit by applying fingerprint recognition techniques to identify. For example, in the health sector, it is quite important to use fingerprint recognition to identify the person injured in an accident.

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