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FACE RECOGNITION TECHNIQUES : A SYSTEMATIC LITERATURE REVIEW (RESEARCH TRENDS, DATASETS, AND METHODS)

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ABSTRACT

Recent research on face recognition techniques typically results in datasets and methods that enable image processing to concentrate on image quality development. Numerous datasets and methods for face recognition techniques are published in disparate and complex formats, and thus a comprehensive overview of the current state of face recognition techniques research is missing. The objective of this literature review is to identify and analyze the research trends, datasets, and methods used in research on face recognition techniques between 2015 and 2020. The systematic literature review (SLR) approach was used to conduct this review of the literature. A systematic review of the literature is defined as the process of identifying, evaluating and interpreting all available research evidence to elucidate specific research questions. The steps are to ascertain what SLR requires, develop a review protocol, conduct a search for primary studies, select primary studies, extract data from primary studies, assess primary studies, analyze data from primary studies, and synthesize data from primary studies. 28 face recognition techniques studies published between 2015 and 2020 were retained and further investigated based on the defined inclusion and exclusion criteria. According to the analysis of the primary studies, current face recognition research focuses on six methods or techniques: PCA, CNN, SVM, Gabor, HOG, and LBP. The six most frequently used classification techniques in face recognition account for 25% of all techniques: PCA, 20% of Gabor, 20% of SVM, 15% of CNN, 10% of LBP, and 10% of HOG. Additionally, 78% of research studies analyzed public datasets, while 22% analyzed private datasets. This essay is structured as follows. Section 1 contains an introduction to the research and research's problem, research objective and problem statement. Section 2 contains the research methods using Systematic Literature Review, and Section 3 discusses the Results and Finding. Section 4 contains the Conclusion

Keywords : SLR, Face Recognition Techniques, Primary Studies, Synthesize

1. INTRODUCTION

Computer science, specifically image processing, is concerned with face recognition. Face recognition has received a great deal of research. Because this field applies to a variety of fields, including crowd surveillance, security systems, control, border building accessibility, law enforcement, identifying missing children, and verifying duplicate enrollments [1]. Additionally, many countries rely heavily on the human face for identity verification via electronic passport gates and

for visa screening by immigration departments [2]. A human being can be identified by his or her unique characteristics, including fingerprints, eyes, iris, and other body structures. The face is a vital part of the body, as it aids in recognition and social interactions [3]. Resolution is critical for facial recognition, as well as detection and recognition of facial features in public surveillance. The first step is to determine whether the image contains a face. The overall features of the face, such as the eyes, lips, nose, and mouth, can be used to identify it [4]. The face

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detection algorithm's primary objective is to determine whether an image contains a single face or multiple faces. Faces are primarily two-dimensional (2D) and three-dimensional (3D) in nature, with a variety of textures and facial expressions. [5]. Face recognition is one of the most widely used applications in a variety of fields, where it can be used in place of a password or to identify criminals. Face recognition performance is influenced by a variety of factors, including pose, illumination, expression, occlusion, and image resolution [6]

Face recognition, as one of the applications of image analysis, is a classic security problem that continues to be a hot topic in computer vision and image understanding. Although research on automatic face recognition has been conducted since the 1960s, the problem remains largely unsolved [7], as a result of its numerous practical applications in the fields of biometrics, information security, access control, law enforcement, smart cards, and surveillance systems, face recognition is one of the researches in the area of pattern recognition & computer vision.

Since the 1960s, research on automatic human facial recognition, dubbed Automated Face Recognition (AFR), has been conducted. However, with the discovery of Eigenfaces in the 1990s, the new AFR gained popularity [8]. In 2014, Facebook claimed that DeepFace, a facial recognition system it developed, had a 97.35 percent accuracy rate with a standard deviation of 0.25 percent when tested against the LFW face verification database [9]. The following year, Yl Sun et al. developed an AFR called DeepID that achieved 97.45 percent accuracy with a standard deviation of 0.26 when tested against the LFW database [10]. DeepID developed into DeepID2 with a 99.15 percent accuracy and a standard deviation of 0.13 percent [11]. DeepID2 was upgraded to DeepID2+, which boasts a 99.47 percent accuracy rate and a 0.12 percent standard deviation [12]. In 2015, DeepID2+ was upgraded to DeepID3, which now has an accuracy of up to 99.53 percent and a standard deviation of 0.10 percent. [13] . Thus, the best machine learning system available. DeepID3, has surpassed humans in face verification. However, when it comes to facial recognition, DeepID3 achieves the highest accuracy of 96.00 percent. [13].

This research is critical to determine which techniques are most effective for determining the human face in any situation or condition. Although holistic or classical approaches have been frequently used in the past, with the advancement of artificial intelligence technology, human facial recognition techniques have been used in a hybrid manner, which is a combination of holistic and architectural function approaches.

Numerous studies on face recognition have also been conducted using the results of survey reviews. However, in this case, the review technique is quite different; the method or technique is to conduct a Systematic Literature Review (SLR) based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [14]. The PRISMA method is comprised of four stages: identification, screening, eligibility, and inclusion. Thus, this study intends to produce a paper that is qualified based on the results of primary studies conducted using the SLR protocol. To ensure the production of high-quality paper, a quality assessment method was used. Methods of the Cochrane Protocol [15]. Standard parameters for quality assessment have been adapted to the study of engineering in the method set, namely the sequence generator, the type of article, the type of datasets, the outcome data, and the selection outcome reporting. Covidence is the tool that is used to facilitate this stage (https://app.covidence.org) . Additionally, synthesis and analysis, which aims to synthesize information from various studies and sources of reference into a new article that is consistent with the research being conducted. NVIVO is the tool that facilitates this (https://www.qsrinternational.com)

Numerous face recognition techniques, datasets, methods, and frameworks have been published in disparate and complex ways, and as a result, a comprehensive view of the current state of face recognition technique research is lacking.

Between 2015 and 2021, this literature review will identify and analyze research trends, datasets, methods, frameworks, and techniques used in face recognition research. This essay is structured as follows. Section 1 contains an introduction to the research and research's problem, research objective and problem statement. Section 2 contains the research methods using Systematice Literatture Review, and Section 3 discusses the Results and Finding. Section 4 contains the Conclussion.

2. METHODOLOGY

2.1. Review Methods

A systematic approach is used to conduct a review of the literature on the face recognition technique. A systematic review of the literature (SLR) is a wellestablished review technique that adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [14]. An SLR is © 2021 Little Lion Scientific

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defined as a process of identification, screening, eligibility and included.

A As illustrated in Figure 1, SLR consists of three stages: planning, conducting, and reporting the review of literature. The first step is to identify the requirements for a systematic review (Step 1). The purpose of conducting the literature review was discussed in the chapter's introduction. Then, systematic reviews of existing literature on recognition techniques are identified and reviewed. The review protocol was created to guide the review's execution and minimize the possibility of the researcher making an error (Step 2). It defined the research questions, the search strategy, the process of study selection with inclusion and exclusion criteria, the quality assessment, and finally the data extraction and synthesis process.



Figure 1 Systematic Literature Review Steps

2.2. Research Questions

The research questions RQ were specified in order to focus the review. They were developed using the PICOC criteria (Population, Intervention, Comparison, Outcomes, and Context) [16][17]. Table 1 shows the PICOC structure of the research questions.

Population	Face Recognition, Facial
Intervention	FaceRecognitionFaceRecognitionTechniques,PerformanceAnalysis,Accuracy,datasets, evaluation, review,survey
Comparison	n/a
Outcomes	Predicition accuary of face recognition techniques to improve or enhanced of performance evaluation
Context	Studies in industry and academia, small and large datasets.

Table 2 Summarizes th Research Questions and
motivations addressed in this literature review

ID	Research Question	Motivation
RQ1	Which journal is	Identify the most
	the most	significant
	significant journal	journals in the
	in the field of face	field of face
	recognition	recognition
	tehniques	techniques
RQ2	Who are the most	Identify the most
	active and	active and
	influence	influence
	reseacher in the	reseacher in the
	field of face	field of face
	recognition	recognition
	techniques	techniques
RQ3	What are types of	Identify of
	research topic	research topics
	trends chosen by	that are trends in
	researchers in the	the field of face
	field of face	recognition
	recognition	
	techniques	
RQ4	What types of	Identify the types
	datasets are most	of dataset that is
	widely used in the	most widely used

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field of face in the field of f	ace
recognition recognition	
techniques	
RQ5 Which types of Identify which	
methods and types of metho	ds
tehniques are often and techinuque	es
used in the field of are often used	in
face recognition the field of fac	e
techniques recognition	
RQ6 What methods is Identify the	
most often used for method most	
face recognition often used for	
techniques face recognitio	n
RQ7 What methods has Identify metho	ds
the best with relatively	
performance used good	
in face recognition performance, t	0
techniques determine which	ch
models	
consistently ou	t
perform other	
models	
RQ8 What improved Identify metho	d
methods and improvements	and
frameworks are framework	
used in the proposed that a	are
improvement for often used in	
improvement for offen used in	
face recognition making face	

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Face recognition techniques, and datasets are extracted from primary studies to address RQ4–RQ9. Following that, the face recognition techniques, and datasets were analyzed to determine which are significant methods, and datasets in face recognition techniques and which are not (RQ4 to RQ9). RQ4–RQ9 are the primary research questions, while the remaining questions (RQ1–RQ3) help us evaluate the primary studies' context. RQ1–RQ3 provide an overview and synopsis of a specific area of research in the field of face recognition techniques.

The basic mind map for the systematic literature review is depicted in Figure 2. The primary goal of this systematic review is to identify the face regocnition methods, and datasets that are used in face recognition techniques.



Figure 2 Basic mind map of the systematic literature review

2.3. Search Strategis

The search process (Step 4) entails several steps, including the selection of digital libraries, the definition of the search string, and the retrieval of an initial list of primary studies from digital libraries that match the search string. To obtain the most comprehensive set of studies possible, the most widely used literature databases in the field are searched. The following is a list of the digital databases that were accessed. IEEE eXplore, ACM Digital Library, Science Direct, Springer, and Scopus [15].

The search string was developed according to the following steps :

- 1. Identification of the search term from PICOC, especially from population and intervention
- 2. Identification of search terms from research questions
- 3. Construction of search string using identified search terms, Boolean ANDs and Ors

Therefore, the strategy stages in stages anywhere :

1. Scopus document display using the keyword "Face Recognition Technique" against the journal of the conference article as well as the Scopus indexed articles for the last 11 years from 2015 to 2021. The provided keyword is :

TITLE-ABS-KEY ("Face Recognition Techniques") AND (LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-

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TO (PUBYEAR, 2016) OR LIMIT-		Extraction		<u>0 extracted</u>	28 studies to extract
TO (PUBYEAR, 2015)) AND (LIMIT-		TEAM PROGRESS		DIAN ADE, YOU CAN STIL	L
TO (DOCTYPE, "ar") OR LIMIT- TO (DOCTYPE, "cr") OR LIMIT- TO (DOCTYPE "re")) AND (LIMIT-		0 • DONE 0 • STARTED	0 • CONSENSUS 28 • NO VOTES	EXTRACT 28 Continue	
TO (SRCTYPE, "p") OR LIMIT- TO (SRCTYPE, "j"))		Figu	re 6 Including a	and Excluding Crit	eria

- 2. As a result, there are 109 articles that discuss Face Recognition Techniques.
- 3. Selected documents are exported as RIS format files, which contain information about the authors, the document title, the year, the source title, the volume issue, the pages, the citation count, the source & document type, the affiliations, the abstract, and the author keyword.
- Following the acquisition of 109 articles on Facial Recognition Techniques, the review stage was conducted using Covidence tools, generating the following results : File import to Screen

TOTAL ADDED TO SCREEN	REFERENCES	DUPLICATES	ERRORS	IMPORTED
109	109	0	0	109

Figure 3 File Import to Screening

5. Examining the title and abstract to ensure they are pertinent to the chosen study topic. There are 73 relevant articles and 36 irrelevant articles among the 109 articles selected based on title and abstract selection.

Title and abstra	act screening	36 irrelevant	0 studies to screen
TEAM PROGRESS			
109 • DONE 0 • ONE VOTE	O O CONFLICTS O NO VOTES	Dian A you have screene	de, d 109 studies

Figure 4 Title and Abstract Screening

 Full-text screening relevant to the chosen study topic based on the full-text review. Of the 73 articles screened via full-text review, 45 meet the excluded criteria and 28 meet the included criteria; these articles will then be extracted.

Full text review

TEAM PROGRESS		. iki
73 • DONE 0 • ONE VOTE	O O CONFLICTS O O NO VOTES	Dian Ade, you have screened 73 studies

Figure 5 Full Text Review Screening

7. Conducting a quality assessment of articles on the basis of 28 articles that fall under the include criteria category yielded the following results.

2.4. Study Selection

The primate studies were chosen using inclusion and exclusion criteria. Table 3 summarizes the criteria.

Table 3	The	Inclusion	and	Exclusion	Criteria
100000	1110	1		Brerroron	0

Tu alaadia u	A d in d in d
Inclusion	Academic and industrial
Criteria	studies utilizing large and
	small scale datasets
	Studies examining and
	comparing the performance of
	modeling techniques used in
	the field of face recognition
	For studies that have been
	published in both conference
	and journal formats .
	In the case of multiple
	publications of the same study,
	only the most comprehensive
	and recent will be included.
Exclusion	Face recognition techniques
Criteria	have been studied
	insufficiently validated or
	without experimental results.
	Studies examining prediction
	techniques/algorithms
	datasets methods and
	from our strain contouts, all
	irameworks in contexts other
	than face recognition.
	Studies not written in English

The detailed search process is depicted in Figure 7, along with the number of studies identified during each phase. As illustrated in Figure 7, the study selection process (Step 5) involved two steps: excluding primary studies based on their title and abstract and excluding primary studies based on their full text. Exclusions include studies that conduct a literature review and those that do not include experimental results. [14].

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Figure 7 Search and selection primary studies base on PRISMA Methods

The final list of primary studies selected for the first stage included 28 primary studies. Then, we analyzed the complete texts of 28 primary studies. Along with the inclusion and exclusion criteria, we considered the quality of primary studies, their relevance to the research questions, and study similarity.

2.5. Data Extraction

The data from the selected primary studies are used to address the research questions addressed in this review. The data extraction process was completed for each of the 28 primary studies that were chosen (step 6)

Table 4 Data	Extraction Properties Mapped to
	Research Questions

Properties	Research		
		Questions	
Researcher	and	RQ1, RQ2	
Publications			
Research Trends	and	RQ3	
Topics			
Face Recognition Da	atasets	RQ4	
Face Reco	gnition	RQ5	
Techniques	-		
Face Recognition Pr	RQ6, RQ7, RQ8		
Methods			

2.6. Study Quality Assesment and Data Sythesis

The quality assessment of the study (step 8) can be used to direct the interpretation of the synthesis findings and to define the strength of the elaborated inferences. The purpose of data synthesis is to compile evidence from relevant studies to address the research questions. While a single piece of evidence may have a negligible amount of evidence force, the accumulation of several of them can strengthen a point. The data extracted for this review are quantitative as well as qualitative. To synthesize the extracted data for various types of research questions, various strategies were used. Generally, the method of narrative synthesis was used. The data were tabulated according to the questions. Additionally, several visualization tools, such as bar charts, pie charts, and tables, were used to enhance the presentation of the distribution of face recognition techniques and their accurate data.

3. Result and Finding

3.1. The Significant journal in the field of face recognition tehniques

This review of the literature includes 28 primary studies that examine the performance of face recognition techniques. The distribution over time is presented to illustrate how interest in face recognition technology has grown over time.



Figure 8 Distribution of Selected Studies over the Years

The most important face recognition techniques journal, as determined by primary studies, is depicted in Figure 9.

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Figure 9 Journal Publications and Distibution of Selected Studies

The Scimago Journal Rank (SJR) value and =Rand(2,5) categories for the most influential journal on face recognition techniques are shown in Table 5. The following table lists journal publications in order of their SJR value. Table 5 Scimago Journal Rank (SJR) of Selected Journal

No	Journal Publications	SJR	Q Catagory
1	ARPN Journal of	0,24	Q2 in Engineering
	Engineering and Applied		
	Sciences		
2	Computers		Not yet
3	European Journal of	0,15	Q4 in Applied
	Molecular and Clinical		Microbology and
	Medicine		Biotechnology
4	IEEE Signal Processing	1,15	Q1 in Applied
	Letters		Mathematics
5	IEEE Transactions on	1,90	Q1 in Computer
	Information Forensics and		Networks and
	Security		Communication
6	IET Image Processing	0,44	Q2 in Computer Vision
			and Pattern Recognition
7	Image and Vision	1,03	Q1 in Computer Vision
	Computing		and Pattern Recognition
8	Indian Journal of Science	0,11	Q4 in Multidisciplinary
	and Technology		
9	International Arab Journal	0,32	Q2 in Computer Science
	of Information Technology		
10	International Journal of	0,16	Q4 in Computer Science
	Advanced Computer		
	Science and Applications		
11	International Journal of	0,13	Q4 in Computer Science
	Advanced Trends in		
	Computer Science and		
	Engineering		
12	International Journal of	0,14	Q4 in Computer
	Electrical and Electronic		Networks and
	Engineering and		Communications
	Telecommunications		
13	International Journal of	0,00	Not yet
	Emerging Trends in		
	Engineering Research		
14	International Journal of	0,10	Q4 in Computers
	Engineering and Advanced		Science Application
	Technology		

15	International Journal of	0,11	Q4 in Biotechonolgy
	Technology(UAE)		
16	International Journal of	0,10	Q4 in Civil and
	Innovative Technology		Structuiral Engineering
	and Exploring Engineering		
17	International Journal of	0,78	Q1 in Computer Vision
	Machine Learning and		and Pattern Recognition
1.0	Cybernetics		
18	International Journal of	0,34	Q3 in Artificial
	Pattern Recognition and		Intelligence
10	Artificial Intelligence	0.1.5	
19	International Journal of	0,15	Q4 in Computer Science
	Security and its		
20	Applications	0.55	01
20	Journal of Applied	0,55	Q1 in Engineering
21	Research and Technology	0.17	04: 01 : 4
21	Journal of Computational	0,17	Q4 in Chemistry
	and Theoretical		
22	Nanoscience	0.22	
22	Journal of Theoretical and	0,23	Q3 in Computer Science
	Applied information		
22	Me dawa Disersian Lattere D	0.20	02 in Condensed Metter
23	Modern Physics Letters B	0,20	Q5 In Condensed Matter
24	Multimedia Tools and	0.46	01 in Media
24	Applications	0,40	Techonology
25	Ontil	0.48	Ω^2 in Atomic and
25	Opuk	0,40	Molecular Physics and
			Optics
26	Pattern Recognition and	0.34	O3 In Computer
20	Image Analysis	0,54	Graphics and Computer
	inage / marysis		Aided
I		I	7 11000

3.2. The Activity and influence reseacher in the field of face recognition techniques

From the primary studies selected, researchers who contributed and are very active in the field of face recognition techniques research were investigated and identified. Figure 10 illustrates the activity and influence of these researchers.



Figure 10 Influential Researchers and Number of Studies

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3.3. The Types of research topic trends chosen by researchers in the field of face recognition techniques.

The following approaches are accustomed to face recognition [18] :

a. Holistic Related Techniques

The experience spot is used as feedback data in this system's natural strategy. Among the best examples of healthy methods are Eigenfaces (the newest method for face recognition), Primary Component Analysis, Linear Discriminant Analysis, and Independent Component Analysis, among others.

- b. Function-based (architectural) Techniques This method begins by extracting nearby capabilities such as the eyes, nose, and mouth and then feeding their locations and associated research (geometric and/or visual) into a structural classifier. A significant concern for methods of character removal is "recovery", or the process by which the program attempts to recover functions that may have been hidden as a result of significant changes.
- c. Hybrid Techniques

Hybrid face recognition programs employ a combination of the two. Generally, 3D images are used in conjunction with hybrid techniques. The graphic of a person's encounter is captured in three dimensions, allowing the device to discern the shape of the face or temple, for example. Since the program makes use of a dimension axis, which provides it with sufficient information to construct the entire experience, and the range that a face in the report could provide. Frequently, the 3D process proceeds as follows: Recognition of Placement, Description, Rendering, and Corresponding. Diagnosis - Capturing an authentic experience by examining an image or photographing someone's face in real-time. Orientation -Establishing the direction, dimension, and position of the head. Measurement - Assigning size to each bend of the face area to create a format that emphasizes the position of the nose and the surface of the eye. Representation -Converting the template to code - illustrating Matching and the face - Conducting research with people on the received information in the current repository.



Figure 11 Distribution of Research Topics

3.4. The types of datasets are most widely used in the field of face recognition techniques

A dataset is a collection of data that is used for machine learning. A training set is a collection of data that is fed into a learning system, which analyzes it to build a model. This review of the literature includes 18 primary studies that examined the performance of face recognition techniques. Figure 12 illustrates the distribution of dataset types used in research studies. 78 percent of studies used public datasets, while 22% used private datasets.



Figure 12 Total Distribution of Datasets

The distribution over time is shown to demonstrate how interest in specific dataset types has fluctuated over time. The distribution of primary studies over time and by the source is depicted in Figure 13. Since 2015, more studies and public datasets have been used to research face recognition techniques. Additionally, researcher awareness regarding the use of public datasets has increased.

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Figure 13 Distribution of Private and Public Datasets

3.5. The types of techniques are often used in the field of face recognition techniques

As illustrated in Figure 14, twelve techniques have been applied and proposed as the best method for face recognition since 2015. Figure 14 summarizes the state-of-the-art technique for face recognition:



Figure 14 Techniques in Face Recognition

3.6. The methods is most often used for face recognition techniques

The six most frequently used classification techniques in face recognition are identified from the twelve techniques depicted in Figure 14 in Section 3.5. Figure 15 illustrates the techniques. They are: PCA, CNN, SVM, Gabor, HOG, and LBP



Figure 15 Most Used Methods or Techniques in Face Recognition

3.7. The methods has the best performance used in face recognition techniques

It has been demonstrated through studies that facial recognition techniques on the ORL and Yale Face datasets perform better than LBP and HOG techniques on both datasets. [19]. PCA is a technique for extracting a feature from an image object in order to improve performance by at least 30% on average when using the technique [20]. According to another study, face recognition can be accomplished by combining feature extraction techniques with HOG and LBP with classification using the Support Vector Machine (SVM) algorithm. The algorithm demonstrated the best performance in binary classification when used to solve security system problems in theft and crime investigations [21].

3.8. Proposed Method Improvement for Face Recognition Techniques

Face recognition techniques can be improved in three ways: 1) Feature Selection, 2) Feature Extraction, and 3) Parameter Optimization. Yinghui's research [22] optimized face recognition by using the LBP Algorithm to extract the feature of a face texture with a degree of accuracy greater than 90%. Additionally, Serign Modou Bah and Fang Ming improved face recognition accuracy by combining LBP algorithms with image processing techniques such as contrast adjustment, bilateral filtering, histogram equalization, and image blending. [23]. Additionally, a study by Mohammad Hasan Abdulameer et al. on face recognition improvement successfully conducted ten experiments on the YALE and CASIA datasets by combining support vector machine (SVM) and Adaptive-Opposition Particle Swarm Optimization (AOPSO) algorithms, resulting in an increase in accuracy of between 81 and 86.9 percent for YALE

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datasets and an increase in accuracy of between 81 and 86.9 percent for CASIA datasets [24].

4. CONCLUSION AND FUTURE WORKS

The purpose of this literature review is to identify and analyze trends, datasets, methods, and frameworks used in research on face recognition techniques between 2015 and 2020. Finally, 28 face recognition techniques studies published between 2015 and 2020 were retained and investigated based on the designed inclusion and exclusion criteria. This review of the literature was conducted in a systematic manner. A systematic review of the literature is defined as the process of identifying, evaluating, and interpreting all available research evidence in order to answer specific research questions.

Twelve techniques have been applied and proposed as the best method for face recognition since 2015. From the twelve methods, six most applied methods in face recognition techniques are identified. The are PCA, Gabor, SVM, CNN, LBP, and HOG.

According to the analysis of the primary studies, current face recognition research focuses on six methods or techniques: PCA, CNN, SVM, Gabor, HOG, and LBP. The six most frequently used classification techniques in face recognition account for 25% of all techniques: PCA, 20% of Gabor, 20% of SVM, 15% of CNN, 10% of LBP, and 10% of HOG. Additionally, 78% of research studies analyzed public datasets, while 22% analyzed private datasets.

The future research on face recognition will focus on illumination, occlusion, and low resolution. While the techniques that will frequently be used in future research are hybrid in nature, combining holistic and function-based techniques.

REFERENCE

- [1] S. H. Abdurrahim, S. A. Samad, and A. B. Huddin, "Review on the effects of age, gender, and race demographics on automatic face recognition," *Vis. Comput.*, vol. 34, no. 11, pp. 1617–1630, Nov. 2018.
- [2] B. Schouten and B. Jacobs, "Biometrics and their use in e-passports," *Image Vis. Comput.*, vol. 27, no. 3, pp. 305–312, 2009.
- [3] X. Wu, J. Xu, J. Wang, Y. Li, W. Li, and Y. Guo, "Identity authentication on mobile devices using face verification and ID image recognition," *Procedia Comput. Sci.*, vol. 162, no. Itqm 2019, pp. 932–939, 2019.
- [4] I. A. Kakadiaris et al., "3D-2D face

recognition with pose and illumination normalization," *Comput. Vis. Image Underst.*, vol. 154, pp. 137–151, 2017.

- [5] D. Sadhya and S. K. Singh, "A comprehensive survey of unimodal facial databases in 2D and 3D domains," *Neurocomputing*, vol. 358, pp. 188–210, 2019.
- [6] A. S. Abdullah, M. A. Abed, and I. Al-Barazanchi, "Improving face recognition by elman neural network using curvelet transform and HSI color space," *Period. Eng. Nat. Sci.*, vol. 7, no. 2, pp. 430–437, 2019.
- [7] D. N. Parmar and B. B. Mehta, "Face Recognition Methods & Applications," vol. 4, no. 1, pp. 84–86, 2014.
- [8] M. Turk and A. Pentland, "Eigedces for Recognition," J. Cogn. Neurosci., vol. 3, no. 1, 1991.
- [9] Y. Taigman, M. Yang, M. Ranzato, and L. Wolf, "DeepFace: Closing the Gap to Human-Level Performance in Face Verification," in 2014 IEEE Conference on Computer Vision and Pattern Recognition, 2014, pp. 1701– 1708.
- [10] Y. Sun, X. Wang, and X. Tang, "Deep learning face representation from predicting 10,000 classes," *Proc. IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognit.*, pp. 1891– 1898, 2014.
- [11] Y. Sun, Y. Chen, X. Wang, and X. Tang, "Deep learning face representation by joint identification-verification," *Adv. Neural Inf. Process. Syst.*, vol. 3, no. January, pp. 1988– 1996, 2014.
- [12] Y. Sun, X. Wang, and X. Tang, "Deeply learned face representations are sparse, selective, and robust," *Proc. IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognit.*, vol. 07-12-June, pp. 2892–2900, 2015.
- [13] X. Tang, "DeepID3: Face Recognition with Very Deep Neural Networks," pp. 2–6, 2015.
- [14] M. J. Page *et al.*, "The PRISMA 2020 statement: An updated guideline for reporting systematic reviews," *Int. J. Surg.*, vol. 88, no. March, p. 105906, 2021.
- [15] E. Runjic *et al.*, "Following Cochrane review protocols to completion 10 years later: a retrospective cohort study and author survey," *J. Clin. Epidemiol.*, vol. 111, no. 1, pp. 41–48, 2019.
- [16] Barbara Kitchenham, "Guidelines for performing Systematic Literature Reviews in

<u>15th November 2021. Vol.99. No 21</u> © 2021 Little Lion Scientific



ISSN: 1992-8645

www.jatit.org

Software Engineering," *IEEJ Trans. Ind. Appl.*, vol. 126, no. 5, pp. 589–598, 2007.

- [17] B. Kitchenham, O. Pearl Brereton, D. Budgen, M. Turner, J. Bailey, and S. Linkman, "Systematic literature reviews in software engineering - A systematic literature review," *Inf. Softw. Technol.*, vol. 51, no. 1, pp. 7–15, 2009.
- [18] R. Tyagi, G. S. Tomar, and N. Baik, "A survey of unconstrained face recognition algorithm and its applications," *Int. J. Secur. its Appl.*, vol. 10, no. 12, pp. 369–376, 2016.
- [19] S. Garg, S. Mittal, and P. Kumar, "Performance analysis of face recognition techniques for feature extraction," *J. Comput. Theor. Nanosci.*, vol. 16, no. 9, pp. 3830–3834, 2019.
- [20] R. Moghekar and S. Ahuja, "Face recognition: Literature review with emphasis on deep learning," *J. Theor. Appl. Inf. Technol.*, vol. 97, no. 12, pp. 3332–3342, 2019.
- [21] S. Singh, D. Singh, and V. Yadav, "Face recognition using hog feature extraction and svm classifier," *Int. J. Emerg. Trends Eng. Res.*, vol. 8, no. 9, pp. 6437–6440, 2020.
- [22] Y. Zhu and Y. Jiang, "Optimization of face recognition algorithm based on deep learning multi feature fusion driven by big data," *Image Vis. Comput.*, vol. 104, p. 104023, 2020.
- [23] S. M. Bah and F. Ming, "An improved face recognition algorithm and its application in attendance management system," *Array*, vol. 5, no. November 2019, p. 100014, 2020.
- [24] M. H. Abdulameer, D. A. Mohammed, S. A. Mohammed, M. Al-Azawi, Y. M. H. Al-Mayali, and I. A. Alameri, "Face recognition technique based on adaptive-opposition particle swarm optimization (AOPSO) and support vector machine (SVM)," *ARPN J. Eng. Appl. Sci.*, vol. 13, no. 6, pp. 2259–2266, 2018.
- [25] M. Murali, "Principal component analysis based feature vector extraction," *Indian J. Sci. Technol.*, vol. 8, no. 35, 2015.
- [26] J. H. Shah, M. Sharif, M. Raza, M. Murtaza, and Saeed-Ur-rehman, "Robust face recognition technique under varying illumination," *J. Appl. Res. Technol.*, vol. 13, no. 1, pp. 97–105, 2015.
- [27] R. Tyagi, G. S. Tomar, and N. Baik, "A survey of unconstrained face recognition algorithm and its applications," *Int. J. Secur. its Appl.*, vol. 10, no. 12, pp. 369–376, 2016.
- [28] M. Chihaoui, A. Elkefi, W. Bellil, and C. Ben Amar, "A survey of 2D face recognition techniques," *Computers*, vol. 5, no. 4, 2016.

- [29] S. Fernandes and J. Bala, "A comparative study on various state of the Art face recognition techniques under varying facial expressions," *Int. Arab J. Inf. Technol.*, vol. 14, no. 2, pp. 254–259, 2017.
- [30] N. Durga Rao, S. ThatherBasha, P. Balakrishna, and D. Bullibabu, "Face recognition by phase congruency modular kernel principal component analysis," *Int. J. Electr. Electron. Eng. Telecommun.*, vol. 6, no. 2, pp. 30–36, 2017.
- [31] Q. Liu, C. Wang, and X. yuan Jing, "Dual multi-kernel discriminant analysis for color face recognition," *Optik (Stuttg).*, vol. 139, pp. 185–201, 2017.
- [32] A. Ragab, X. de Carné de Carnavalet, S. Yacout, and M. S. Ouali, "Face recognition using multi-class Logical Analysis of Data," *Pattern Recognit. Image Anal.*, vol. 27, no. 2, pp. 276–288, Apr. 2017.
- [33] M. Lal, K. Kumar, R. H. Arain, A. Maitlo, S. A. Ruk, and H. Shaikh, "Study of face recognition techniques: A survey," *Int. J. Adv. Comput. Sci. Appl.*, vol. 9, no. 6, pp. 42–49, 2018.
- [34] S. Channagoudar and K. Srikanta Murthy, "Efficient feature extraction for face recognition with combined method of PCA and GMM," *Int. J. Eng. Technol.*, vol. 7, no. 3.34 Special Issue 34, pp. 766–769, 2018.
- [35] Y. Su, Z. Liu, and M. Wang, "Sparse representation-based face recognition against expression and illumination," *IET Image Process.*, vol. 12, no. 5, pp. 826–832, 2018.
- [36] M. Chandrakala and S. Ravi, "Effective 3d face recognition technique based on gabor and ltp features," *Int. J. Eng. Adv. Technol.*, vol. 8, pp. 284–290, 2018.
- [37] S. Sharma and V. Kumar, "Performance evaluation of 2D face recognition techniques under image processing attacks," *Mod. Phys. Lett. B*, vol. 32, no. 19, 2018.
- [38] G. Kumar Lokku, G. H. Reddy, and M. N. G. Prasad, "Automatic Face Recognition for Various Expressions and Facial Details," *Int. J. Innov. Technol. Explor. Eng.*, vol. 8, no. 983, pp. 264–268, Aug. 2019.
- [39] D. Heinsohn, E. Villalobos, L. Prieto, and D. Mery, "Face recognition in low-quality images using adaptive sparse representations," *Image Vis. Comput.*, vol. 85, pp. 46–58, May 2019.
- [40] S. Chokkadi, M. S. Sannidhan, K. B. Sudeepa, and A. Bhandary, "A study on various state of the art of the art face recognition system using deep learning techniques," *Int. J. Adv. Trends*

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E-ISSN: 1817-3195

Comput. Sci. Eng., vol. 8, no. 4, pp. 1590–1600, 2019.

- [41] J. Chen, J. Chen, Z. Wang, C. Liang, and C. W. Lin, "Identity-Aware Face Super-Resolution for Low-Resolution Face Recognition," *IEEE Signal Process. Lett.*, vol. 27, no. PG-645-649, pp. 645–649, 2020.
- [42] S. Merikapudi, S. Math, C. Nandini, and M. Rafi, "Face recognition using cnn trained with histogram equalization based image enhancement scheme," *Eur. J. Mol. Clin. Med.*, vol. 7, no. 8, pp. 2940–2950, 2020.
- [43] M. O. Oloyede, G. P. Hancke, and H. C. Myburgh, "A review on face recognition systems: recent approaches and challenges," *Multimed. Tools Appl.*, vol. 79, no. 37–38, pp. 27891–27922, 2020.
- [44] M. Tabejamaat, A. Mousavi, and M. L. Gavrilova, "Local comparative decimal pattern for face recognition," *Int. J. Pattern Recognit. Artif. Intell.*, vol. 34, no. 12, 2020.
- [45] Y. Qin, L. Sun, and Y. Xu, "Exploring of alternative representations of facial images for face recognition," *Int. J. Mach. Learn. Cybern.*, vol. 11, no. 10, pp. 2289–2295, 2020.
- [46] W. Ali, W. Tian, S. U. Din, D. Iradukunda, and A. A. Khan, *Classical and modern face recognition approaches: a complete review*, vol. 80, no. 3. Multimedia Tools and Applications, 2021.

Journal of Theoretical and Applied Information Technology <u>15th November 2021. Vol.99. No 21</u> © 2021 Little Lion Scientific



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Year	Primary Studies	Publication	Datasets	Techniques	Types of Research Topics
2015	(Murali, M., 2015) [25]	Indian Journal of Science and	Yale-B	PCA	Holistic
	(Shah, J.H.; Sharif, M.; Raza, M.; Murtaza, M.; Saeed-Ur-rehman, 2015) [26]	Technology Journal of Applied Research and Technology	Yale-B, CMU-PIE	LDA, KDA	Holistic
2016	(Tyagi, R.; Tomar,	International Journal of Security	None	RFG	Function-based
	G.S.; Baik, N.) [27] (Chihaoui, M.; Elkefi, A.; Bellil, W.; Amar, C.B.) [28]	and its Applications Computers	AR, ORL, Yale, Feret	Eigenface, LEM, SVM+PCA, SVM+ICA	Holistic
2017	(Fernandes, S.; Bala, J.) [29]	International Arab Journal of Information Technology	ATT, JAFFE, FEI	DCT, HDR, LGCF, CSM,SLFT	Holistic
	(Durga Rao, N.; ThatherBasha, S.; Balakrishna, P.; Bullibabu, D.) [30]	International Journal of Electrical and Electronic Engineering and Telecommunications		NM-KPCA	Holistic
	(Liu, Q.; Wang, C.; Jing, XY.) [31]		LFW	DMDA	Holistic
	(Ragab, A.; de Carné de Carnavalet, X.; Yacout, S.; Ouali, MS.) [32]	Pattern Recognition and Image Analysis	JAFFE, UMIST	Eigenface, Fisherfaces	Holistic
2018	(Abdulameer, M.H.; Mohammed, D.A.; Mohammed, S.A.; Al- Azawi, M.; Al-Mayali, Y.M.H.; Alameri, I.A.) [24]	ARPN Journal of Engineering and Applied Sciences	YALE, CASIA	SVM+PSO	Holistic
	(Lal, M.; Kumar, K.; Arain, R.H.; Maitlo, A.; Ruk, S.A.; Shaikh, H.) [33]	International Journal of Advanced Computer Science and Applications	FERET, LFW, YTF	ANN, SVM, PCA, ICA, Gabor Wavalet, EBGM	Holistic
	(Channagoudar, S.;	International Journal of Engineering and Technology(UAE)		PCA, GMM	Holistic
	Srikanta Murthy, K.) [34]	IET Image Processing	MultiPIE, CK, AR	SCIP	Function-based
	(Su, Y.; Liu, Z.; Wang, M.) [35]	International Journal of Engineering and Advanced	CASIA-3D	Gabor , LTP	Hybrid
	(Chandrakala, M.; Ravi, S.) [36]	Technology	UMBDB	DA, SVM, k- NN	Holistic
	(Sharma, S.; Kumar, V.) [37]				
2019	(Kumar Lokku, G.; Reddy, G.H.; Prasad, M.N.G.) [38]	International Journal of Innovative Technology and Exploring Engineering	ORL	PCA	Holistic
	/ L- *]	Image and Vision Computing	AR	LBP, Gabor Wavalet, HOG	Holistic

Table 6 The List of Primary Studies in the Field of Face Recognition Techniques

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	(Heinsohn, D.;				
	Villalobos, E.; Prieto,				
	L.; Mery, D.) [39]			Deeplearning	
		Journal of Theoretical and Applied	LFW		Hybrid
	(Moghekar, R.; Ahuja,	Information Technology			
	S.) [20]				
			ODI VI	LBP, Gabor	TT 11 .1
		Journal of Computational and	ORL, Yale	Wavalet, HOG	Holistic
	(Garg, S.; Mittal, S.;	I heoretical Nanoscience			
	Kumar, P.) [19]			Generative	
			4.D	Adversarial	
		The section of information	AK,	Network	Functions-based
	(L1, P.; Prieto, L.;	Forensics and Security	MegaFace,	(GAN)	(architectural)
	Mery, D.; Flynn, P.J.)		VDOLO		
			VBOLO,		
	(Chaldradi S.	International Journal of Advert-1	UCUSFace	CNN	
	Chokkaul, S.;	Trends in Computer Science and		CININ	Hybrid
	Salillullall, WI.S.,	Engineering			riyona
	Dhandamy A) [40]				
2020	Chen I: Wong 7:	IEEE Signal Processing Latters	I FW Calab	PC A	Holistic
2020	(Clieff, J., Wallg, Z., Liang C: Lin C-W)	TEEE Signal Flocessing Letters	A Celeb-	FCA	nonsue
	[/1]		Λ		
	[+1]				
		International Journal of Emerging		SVM	Holistic
	(Singh, S.: Singh, D.:	Trends in Engineering Research		5 1 11	lionsue
	Yaday, V.) [21]				
		European Journal of Molecular and	YTF, IJB-A	CNN	Functions-based
	(Merikapudi, S.; Math,	Clinical Medicine	,		(architectural)
	S.; Nandini, C.; Rafi,				`
	M.) [42]				Functions-based
		Multimedia Tools and Applications	Yale, CMU-		(architectural)
			PIE, AR		
	(Oloyede, M.O.;				Hybrid
	Hancke, G.P.;				
	Myburgh, H.C.) [43]	International Journal of Pattern	ORL, GT,	LCDP	
		Recognition and Artificial	LFW		
	(m. 1.)	Intelligence			Functions-based
	(Tabejamaat, M.;				(architectural)
	Mousavı, A.;			MBLP-CNN	
	Gavrilova, M.L.) [44]	Multimedia Tools and Applications			
					Eurotion - 1 1
	(Silwal D + Alandoor				runcuons-based
	$\Delta \cdot Prasad P W C \cdot$				(architectural)
	Alsodoon $OH \cdot Al$		GT FERET	CR INNC	
	Oaraghuli A) [44]	International Journal of Machine	ORL	cit, intro	
	ו•••6•••••••••••	Learning and Cybernetics			
	(Qin, Y.; Sun, L.; Xu,				
	Y.) [45]				

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ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195 ARPN Journal of Engineering and Applied Sciences Computers European Journal of Molecular and Clinical Medicine IEEE Signal Processing Letters IEEE Transactions on Information Forensics and Security IET Image Processing Image and Vision Computing Indian Journal of Science and Technology RQ8: Proposed Methods International Arab Journal of Information Technology to Improvement International Journal of Advanced Computer Science and Applications International Journal of Advanced Trends in Computer Science and Engineering International Journal of Electrical and Electronic Engineering and Telecommunications RQ7: The best performance International Journal of Emerging Trends in Engineering Research of Methods RQ1: Significant Journal International Journal of Engineering and Advanced Technology International Journal of Engineering and Technology(UAE) PCA International Journal of Innovative Technology and Exploring Engineering ÇNN International Journal of Machine Learning and Cybernetics SVM International Journal of Pattern Recognition and Artificial Intelligence RQ6: methods is most often used Gabor International Journal of Security and its Applications HOG Journal of Applied Research and Technology Face Recognition LBP Journal of Computational and Theoretical Nanoscience Techniques Journal of Theoretical and Applied Information Technology PCA Modern Physics Letters B CNN Multimedia Tools and Applications **SVM** Optik Gabor Pattern Recognition and Image Analysis HOG RQ5: types of techniques LBP Abdulameer, M.H.; Ali, W.; Chandrakala, Channagoudar, S.; Chen, J.; Chihaoui, M.; Cholkhadi, S.; Durga Rao, N.; Fernandes, S.; Garg, S.; Heinsohn, D.; Kumar Lokku, G.; Lal, M.; Li, P.; Liu, Q.; Menkapudi, S.; Moghekar, R.; Murali, M.Oloyede, M.O.; Qin, Y.; Ragab, A.; Shah, J.H.; Sharma, S.; Silwal, R.; Singh, S.; Su, Y.; Tabejamaat, M.; Zurei, D. are often used GAN RQ2: Influential Researcher Eigenface Tyagi, R. LDA ICA Holistic Related Techniques k-NN RQ3: Research Topics and Trends Function-based (architectural) Techniques Hybrid Techniques Private Datasets LFW, Yale-B, AR, ARL, FERET, JAFFE, FEI, UMIST, CASIA, YTF, UMBDB MegaFace, SCFace, UCCSFace, RQ4: Face Recognition Datasets Public Datasets Celeb-A,IJB-A

Figure 16 Complete Mind Map of the SLR on Face Recognition Techniques