

# Partial Face Detection and Recognition by Matching Dynamic Features

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*Abstract-Face recognition is human detection by the unique features on their Faces. Face recognition technology is the least intrusive and quickest bio-metric technology. This deals with the human face's most visible individual recognition. With increased security demands and developments in the processing of information technology, it has become much easier. The Face is one of the important biometric features in case of identification and authorization. In many applications such as video surveillance and facial object database management, human face detection and recognition play important roles. Face recognition has achieved great progress in the last few years. But developing a computational model for face detection and recognition is one of the most difficult tasks. Partial face recognition (PFR) in an unconstrained environment is a very important task, especially in situations where partial face images are likely to be captured due to occlusions, out-of-view, and large viewing angle, such as video surveillance and mobile devices, cameras. The system first detects faces and recognizes a novel partial face recognition approach, called Dynamic Feature Matching (DFM), which uses Neural Networks concept (NNs) and Classifiers (SRC) to address partial face recognition problem regardless of various face sizes. DFM does not require prior position information of partial faces against a holistic face.*

**Keywords — Dynamic feature matching, Partial face recognition, Neural Network, Semantic Segmentation classifier.**

## Introduction

Face recognition has achieved nice progress in the past few years using the fast development of the deep convolutional network. Out of all biometric methodology, the face is most well-liked because it is captured simply from a protracted distance. Face recognition deals with confirmative and distinctive a face from its image information. Identification is outlined because the method of the action or process distinctive somebody or one thing or the very fact of being known. Identification can be done using various types like documents, using biometric, or using physiological biometrics such as fingerprint scan, face recognition, retina recognition, and iris recognition.

The activity biometrical identifications are voice recognition and face recognition however a private is expeditiously known mistreatment face recognition as a face is solely biometric for all.

In past years, one among the foremost trusty choices for substantiative people is biometric based mostly recognition. But after some years it was observed that fingerprint gets change according to time or work. In function of substantiating individuals and permitting them to own physical access on their passwords, PINs, sensible cards, plastic cards, tokens, keys and then forth, an individual's physiological and/or behavioral characteristics are verified by these strategies as a result of that hacking are often done simply which may determine and/or ascertain his identity. However, associate individual's biological characteristics cannot be lost, forgotten, taken or counterfeit. Face recognition has achieved nice success over precedence year because of the agile development of deep convolutional neural networks (CNNs)[2]and it's used widely in several sensible eventualities, as well as banking, border management, and mobile lock and sign language systems. Although the achievement of face recognition algorithms [6, 7, 4, 5] are upgraded using various advanced technology, most of the algorithms cannot properly handle partial faces in computational environments without user cooperation. It is observed in a typical picture which is captured by a video surveillance camera, and mobile camera, a face maybe 1) obscuration by varied things like faces of different humans, sunglasses, a hat or a scarf; 2)poses captured of assorted users while not their awareness; generally person's position is outside the camera's read. police work footage is a very important clue for investigation of any police case wherever criminal suspects show just some a part of their face. Therefore, it's necessary to develop a partial face recognition system that works for each holistic face and partial faces [1].

Partial face recognition using feature matching is very necessary because the face is obscured by many objects. Therefore choosing an algorithm for feature extraction and classifier is a vital task. Fig.1.1. present the images of partial faces in an intricate environment.

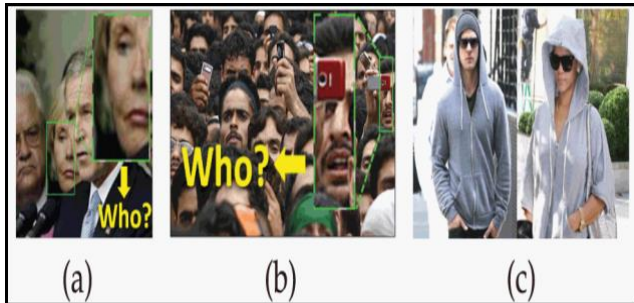


Fig. 1.1. Partial face image captured in an intricate environment. A face may be (a) obscured by sunglasses or a cap or scarf. (b) obscured by faces in front of other human face or mobiles.[9]

In the above image, there are three environments displayed from which first image (a), showing the face is occluded by the face of other humans in front. In an image (b), the face is occluded by mobile phones or other objects. In image (c), the face is occluded by scarf, goggles, and cap. In such environments, face recognition can't do properly. Partial face recognition may be a specific and exhausting case of visual perception. The perplexity of this issue stems from the very fact that in their most frequent kind, faces seem to be roughly identical and also the diversity between them is kind of delicate. Images are captured from wide angles; as a result of this typically the face can't be recognized simply. What is more, the face may be a distinctive, rigid object. Furthermore, the human face is a unique, rigid object.

Indeed there are numerous factors that cause the variation in the appearance of the face. The variations in the facial outward aspects can be divided into two groups: one is intrinsic factors and another is an extrinsic factor. Intrinsic factors are completely dependent on the physicality of the face and independent of the spectator. These factors can be further subdivided into two classes: intrapersonal and interpersonal. The same person has a different facial appearance. Such appearances are enclosed in Intrapersonal factors like age, facial character, etc. totally different persons carry with it different appearances that are enclosed in social factors like gender and facial character. Different persons consist of different

appearances which are included in interpersonal factors such as gender and ethnicity. The appearance of the face to change via the synergy of light with the face and the spectator is induced by the extrinsic factors. Illumination, pose, scale and imaging parameters like resolution, focus, imaging, noise, etc are a number of the factors enclosed in unessential factors.

### Motivation

Each data is processed with artificial intelligence by the computer in today's automation era and used in many sophisticated applications. Although the state-of-the-art security systems have been developed by many organizations, recent terrorist attacks revealed serious weaknesses of advanced security systems. Many organizations are therefore more serious about improving safety data systems based on body or behavioral features, also called biometrics. Almost all biometric technologies allow the user to take some voluntary action, i.e. the user must place his hand on a hand-rest for fingerprinting or hand geometry detection and stand in a fixed position in front of an iris or retina recognition camera. However, face recognition can be achieved passively without any definite intervention or involvement on the user's 2nd side, as face images can be collected by a camera from a distance, making the face recognition device more appropriate for safety and monitoring purposes. In contrast, for other biometric techniques that rely on hands and fingers, data acquisition in general is fraught with problems. These can be made useless if the tissues of the epidermis are damaged (i.e. bruised or cracked) in some way. For the identification of iris and retina, expensive equipment is needed, and these methods are more sensitive to any body movement. Voice recognition is prone to background noise on a telephone line or tape recording in public places and auditory variations. It is possible to modify or forge signatures. With a few inexpensive fixed cameras, however, facial images can be easily obtained. They cannot be changed or copied, so ambient sound noise does not affect them. Face recognition algorithms with sufficient image pre-processing can account for noise, slight variations in direction, size and illumination.

Researchers' ultimate goal in this field is to establish sophisticated face recognition to mimic the process of human vision. Several researchers suggested and created face recognition algorithms based on the computer. For

the past four decades, work has been actively conducted in the face recognition field, and considerable progress has been made. There is still room for improvement. Encouraging findings have been obtained and when working under different restricted conditions, current face recognition technologies have reached a specific degree of maturity. We are, however, far from achieving the goal of being able to perform sufficiently in all the different situations commonly encountered by applications, using techniques available in practical life.

In this thesis, we concentrate on face recognition of occluded as well as normal face images.

### Objectives

To review existing systems of criminal detection, recognition and identification and to identify criteria for the intelligent partial forensic face detection and identification system.

Develop an intelligent forensic face detection and identification system for security agencies to improve justice and enforcement operations within the departments of criminal investigation. Implementing, reviewing and validating the intelligent forensic facial detection and identification system in real time.

### Literature Survey

Lingxiao He, Haiqing Li, Qi Zhang And Zhenan Sun Proposed Dynamic Feature Matching For Partial Face Recognition In The Year 2019. The Objective Of The Paper Is To Acknowledge A Partial Face For Identity As Several Faces Cannot Match Due To Occlusion. It's Been Broadly Speaking Utilized In Several Realistic Situations, That Embrace Banking, Border Management, Mobile Locks And System Locks. The Datasets Used Are CAISA, Nirdistance, CASIA-Nirmobile, LFW Databases, Thomas Reid And Ilids Databases. It Makes Use Of The Many Dataset For Getting Accuracy And Overall Characteristic Twenty Nine.0% To 32.4%.DFM With Multi-Scale Illustration Might Ease. This Trouble While Getting Atiny Low Machine Price.[1]

Dayong Wang, Charles Otto, Anil K. Jain proposed Face search at scale in the year 2017. The main objective is to acknowledge an individual from the variant LFW databases and recognizing folks on social media platforms. Facebook and (COTS) intermediary options learned by a

convolutional neural network were a number of the techniques and algorithms used. The system finds a younger person in photograph at rank one in one second on a 5M gallery associate degreed at rank eight in seven seconds on an 80M gallery exploitation the deep options with the COTS intermediary improves the general performance ninety nine.5% TAR@FAR of zero.01%. On a true cloud, the system have shown each the practicability and potency of our projected theme. System offers a wonderful trade-off between accuracy and quantifiability on galleries with million of pictures.[8]

Timo Ahonen, abdenour Hadid, and Malli Pietikainen proposed Face description with local binary patterns: Application to face recognition in the year 2006. The objective unique descriptor supported native binary pattern texture options extracted from native facial regions. FERET databases were used. LBP could be a easy however terribly economical texture operator that labels the picture elements of a picture by thresholding the neighborhood of every pixel and considers the result as a binary range. native binary pattern (LBP) texture feature and LBP feature distributions are extracted and enhance for vector as a face descriptor. The LBP operator has been wide utilized in totally different applications like texture classification, image retrieval, etc. Facial pictures are seen as a composition of micropatterns like flat areas, spots, lines, and edges which may be delineated by LBP. The planned system United Statelets employed} LBP that is extremely easy and simple to us assessed with the face recognition task[3]

Ismahane Cheheb, Noor-Al-Maadeed, Somaya Al-Maadeed and Ahmed Bouridane and Richard Jiang proposed Random sampling for patch-based face recognition in the year 2017. The objective is to tackle with partial occlusion distortions due to that face recognition isn't done properly AR face information is employed during this technique. A dataset consisting of options set and labels set, associate degree SVM classifier builds a model to predict categories for brand spanking new examples. More modern technique use native des criptors that in distinction to international descriptors represent the options in native regions and have proven to be simpler. Spatial property reduction victimization Kernel element analysis SVM classifier and sampling technique were a number of the techniques and algorithms used. Demonstrating its Potential particularly that it operates in associate degree

underneath sampled surroundings. The accuracy of the Protection controls has been increased. The projected system U.S.ed|is employed as SVM classifier that is incredibly straightforward and straight forward for us assessed with the face recognition task.[9]

Dr. Ravi Subban, Savitha Soundararajan proposed Human Face Recognition using Facial Feature Detection Techniques. The objective of this can be the study of assorted techniques used for face recognition. ORL and UMIST info are the datasets used for this system. Study applied math foundation is combined into finding technologies. the sector has centred on still, actinic radiation photographic pictures, usually black and white, though' currently interest has begun to be shown within the recognition of faces in colour video.[10]

Lingxiao He, Haiqing Li, Qi Zhang, Zhenan Sun and Zhaofeng He proposed Multiscale Representation for Partial Face Recognition under near Infrared Illumination. The objective of this survey is to develop NIR partial face recognition algorithmic program for iris recognition system. NIRPF and CASIA-IrisV4- Distance databases are created use Network is that the algorithmic program

Shengcai Liao, Anil K. Jain proposed Partial Face Recognition: An Alignment Free Approach. Its objective is: By applying a quick filtering approach it self-addressed to large seeking the sparsest illustration among all the gallery pictures. MKD-SRC is eighty one.31% correct. MKD-SRC a provides higher result than the SIFT.[12]

Jonathan Long , Evan Shelhame, Trevor Darell Proposed Fully Convolutional Networks for Semantic Segmentation. Its objective is: Application for a convolutional neural network.

The dataset used is RGB-D dataset. Convolutional Neural network, absolutely convolutional network square measure a number of the algorithms and techniques used for this purpose.. Visual models that yield hierarchies of options. FCN addresses several pixelwise tasks. FCN for segmentation provides accuracy in improvement on a trained dataset.[13]

Weng R, Lu J, Tan YP Proposed Robust Point Set Matching for Partial Face Recognition. The target is to search out similarity of the two faces is regenerate because

the distance between these two aligned feature sets. The datasets used square measure labelled Face within the Wild (LFW), The AR dataset, EYB info. sturdy Face Recognition Feature Set Matching is that the technique utilized in this respect. RPSM takes around twenty ms to match a combine of probe and gallery keypoints Facial pictures robustly even with the presence of occlusion, random partial crop, and exaggerated facial expressions.[14]

Yueqi Duan, Jiwen Lu, Jianjiang Feng, and Jie Zhou proposed Topology Preserving Structural Matching for Automatic Partial Face Recognition. TPGM technique estimates a non-rigid transformation coding the second order geometric structure of the graph, so additional correct and sturdy correspondence is comp uted with the topological data. SIFT descriptor with the sped up sturdy options (SURF) to boost the strength to illumination variations, and more apply the dimensions Invariant LBP (SILBP) options to take advantage of the elaborate matter data.

Experimental results on four wide used datasets together with labelled Face within the Wild (LFW), PubFig, AR and Extended Yale B (EYB) show the effectiveness of the projected approach. Algorithms, embody domestically Affine Invariant sturdy purpose set Matching (LAIRPM), sturdy purpose Set Matching (RPSM), Metric Learned Extended sturdy purpose Matching (MLERP), Multi-Keypoint Descriptors-Sparse Representation-based Classification-Gabor Ternary Pattern (MKD-SRC-GTP) and Coherent purpose Drift (CPD).[29] Kaiming He, Xiangyu Zhang, Shaoqing Ren, and Jian Sun proposed Spatial Pyramid Pooling in Deep Convolutional Networks for Visual Recognition. The datasets include the Caltech101 dataset which contains 9144 images in 102 categories (one background), the Pascal VOC 2007 and ImageNet dataset

Using SPP-net, the feature maps from the whole image just the once, then pool options in absolute regions (sub-images) to come up with fixed-length representations for coaching the detectors. This technique avoids repeatedly computing the convolutional options. Thin secret writing or Fisher kernels.

These encoded options contains the feature maps, and ar then pooled by Bag-of-Words or spatial pyramids. In process check pictures, our technique is 24-102 quicker than the R-CNN technique, whereas achieving higher or comparable accuracy on Pascal VOC 2007. The networks



with another pooling strategy, “spatial pyramid pooling”, to eliminate the popularity accuracy for the pictures or sub-images of AN absolute size/scale.[30]

Junlin Hu<sup>1</sup>, Jiwen Lu<sup>2</sup>, and Yap-Peng Tan<sup>1</sup> proposed robust partial face recognition using instance-to-class distance. The objective in this paper aims to spot folks from such partial or occluded face pictures. native strategies like native binary patterns (LBP) and scale invariant feature rework (SIFT) square measure additional strong to spatial misalignments and additional free on the feature length, so they will be wont to represent partial faces. Face recognition has been wide investigated over the past twenty years, and an outsized variety of face recognition algorithms are projected within the literature.[31]

Xiaoyang Tan, Songcan Chen, Zhi-Hua Zhou, and Jun Liu proposed Face Recognition Under Occlusions and Variant Expressions With Partial Similarity. The FERET database consists of more than 13 000 facial images corresponding to more than 1500 subjects. Other datasets used are AR face and ORL databases. The diversity of the information is across gender, ethnicity, and age. By coaching, the Kyrgyzstani monetary unit formula will turn out a topological ordering of the feature map within the input house within the sense that neurons that area unit adjacent within the lattice can tend to own similar weight vectors. Another formula that is formed use of is Pd formula and bar chart exploit formula. Two strategies, supported the final golden mean rule and therefore the most margin criterion, severally, area unit planned to mechanically set the similarity threshold.

The effectiveness of the planned technique in handling massive expressions, partial occlusions, mean rule and therefore the most margin criterion, area unit planned to mechanically set the similarity threshold. The effectiveness of the planned technique in handling massive expressions, partial occlusions, and different distortions is incontestable on many well-known face databases.[32]

John Wright, Allen Y. Yang, Arvind Ganesh, S. Shankar Sastry and Yi Ma proposed Robust Face Recognition via Sparse Representation. The objective is to deal with the matter of mechanically recognizing human faces from frontal classifying supported the simplest affine illustration in terms of a try of coaching samples. the simplest familiar rule is combinatorial, and so, solely sensible once the dimension m is moderate. In, Lee et al. according ninetyfive.4 p.c accuracy exploitation the NS methodology on the Yale B information [33]

Niall McLaughlin, Ji Ming, and Danny Crookes proposed, Largest Matching Areas for Illumination and Occlusion Robust Face Recognition. The objective of this paper is to handle uneven illumination, partial occlusion and limited training data. The datasets used are Yale B and AR database. The new approach will help to perform lightning normalization, occlusion deemphasize, and finally face recognition based on the finding the largest matching area (LMA). For feature extraction, robustness is achieved using novel approaches. It also gives best result in corrupted images. LMA works on each point of the face. The model works on single training image for per person on the labelled face dataset [34]

Table-1. Comparative Study

Title	Objective	Dataset	Features	Technique/ Algorithm Used	Accuracy /Result/Conclusion	Remark
Dynamic Feature Matching for Partial Face Recognition (2019)[1]	To recognize a partial face for identification as many faces cannot match because of occlusion	1.CAISA- 2.NIRDistance 3.CASIANIR-Mobile, 4.LFW databases5.RE-ID 6.iLIDS databases	It uses the various dataset for getting accuracy and performance and gets a better result as compared to existing work.	Novel partial face recognition Fully Convolutional Networks (FCNs) Sparse Representation Classification(SRC)	In multi-shot, setting the DFM matching rate is increased from 25.9% (N=1) to 29.9% (N=3) In single-shot experiment setting 25.9% to 27.8%. In facial feature 29.0% to 32.4%	DFM with multi-scale representation could ease this problem while obtaining a small computational cost.
Face search at scale (2017)[8]	To recognize a person from the millions of people and recognizing people on social	LFW databases	COTS matcher improves the overall performance	Coupled with a state-of-the-art commercial off the shelf (COTS) matcher Features	The system finds a younger person in photo at rank 1 in 1 second on a 5M gallery and at rank 8	System offers an excellent tradeoff between accuracy and scalability on

	media platforms.			learned by a convolutional neural network	in 7 seconds on an 80M gallery using the deep features with the COTS matcher improves the overall performance 99.5% TAR@FAR of 0.01%. On a real cloud, the system have shown both the feasibility and efficiency of our proposed scheme	galleries with millions of images.
Face description with local binary patterns: Application to face recognition. (2006)[3]	To recognize a person from the millions of people and recognizing people on the social media platforms.	FERET databases	LBP is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary	Local binary pattern (LBP) texture feature and LBP feature distributions are extracted and enhance for vector as a face descriptor.	The LBP operator has been widely used in different applications such as texture classification, image retrieval, etc. Facial images can be seen as a composition of micropatterns such as flat areas, spots, lines, and edges which can be well described by LBP	The proposed system is used LBP which is very simple and easy to us assessed with the face recognition task
Random sampling for patch-based face recognition. (2017)[9]	To tackle with partial occlusion distortions because of which face recognition is not done properly	AR face database	A dataset consisting of features set and labels set, an SVM classifier builds a model to predict classes for new examples.	Dimensionality reduction using Kernel component analysis SVM classifier Random sampling method	Demonstrating its potential especially that it operates in an under-sampled environment. security controls	The proposed system is used SVM classifier which is very simple and easy for us assessed with the face recognition task
Human Face Recognition using Facial Feature Detection Techniques [10]	Study of various techniques used for face recognition	ORL and UMIST database	Strong statistical foundation Can be combined into libraries	Template Based matching Hidden Markov models Local Binary Pattern	The technologies are best distinguished by the input medium that is used, whether visible light, infrared or 3-dimensional data from stereo or other range finding technologies.	The field has focused on still, visible light photographic images, often black and white, though now interest has begun to be shown in the recognition of faces in color video.
Multiscale Representation for Partial Face Recognition Under Near Infrared Illumination [11]	NIR partial face recognition algorithm is developed for iris recognition system.	NIRPF and CASIAIrisV4-Distance databases	The eye corner is utilized for alignment because mostly eye regions are visible.	Multiscale Double Supervision Convolutional Neural Network	MDSCNN extract exactly distinguish features which is very useful to represent the robust feature.	Partial faces according to the inner and outer corner of each and cuts partial faces into multiscale patches
Partial Face Recognition: An Alignment Free Approach [12]	By applying a fast filtering approach, it addressed to large-scale face recognition problem.	FRGCv2.0 database AR database LFW database	multi key point descriptor based MKD-SRC	suppresses matches between impostor pairs by seeking the sparsest representation among all the gallery images	MKD-SRC is 81.31%.	MKD-SRC a provides better result than the SIFT
Fully Convolutional Networks for	Application for a convolutional	RGB-D dataset	Convolutional Neural network,	Visual models that yield hierarchies of	FCN addresses many pixel-wise tasks.	FCN for segmentation

Semantic Segmentation[13]	neural network		Fully convolutional network.	features		provides accuracy in improvement on a trained dataset
Robust Point Set Matching for Partial Face Recognition [14]	The similarity of the two faces is converted as the distance between these two aligned feature sets.	The Labeled Face in the Wild (LFW) The AR dataset EYB database PubFig	Robust Face Recognition Feature Set Matching	discriminatively match these two extracted local feature sets the textural and geometrical information of local features are explicitly used for matching simultaneously	RPSM takes around 20 ms to match a pair of probe and gallery keypoints	Facial images robustly even with the presence of occlusion, random partial crop, and exaggerated facial expressions
Topology Preserving Structural Matching for Automatic Partial Face Recognition [29]	Features in unconstrained situations in the real world can be obscured by artifacts or other features that cannot represent the entire face picture.	Labeled Face in the Wild (LFW), PubFig, AR and Extended Yale B (EYB)	Simply measure node similarity without geometric graph knowledge of higher order that is susceptible to noise	Multi-key-point descriptor with Gabor ternary pattern (MKDGT) robust point set matching (RPSM)	accuracy, robustness and efficiency of the proposed methods	Because deep learning is only used to extract key-point descriptors, it is important to add deep learning to the matching graph process in order to further improve matching skills
Spatial Pyramid Pooling in Deep Convolutional Networks for Visual Recognition [30]	Reduce the precision of identification of arbitrary size / scale pictures or sub-images	ImageNet 2012, Pascal VOC 2007, Caltech101	SPP-net, unlike image size / scale, can produce a fixed-length representation	SPP-net, R-CNN	On the SPP (ZF-5) model, the accuracy is 89.91% using the SPP layer as features lower than 91.44%	Computer vision techniques/ insights can still play significant roles in deep network identification
Robust partial face recognition [31]	Recognize an artificial facial patch to improve these systems' knowledge	LFW dataset from Yahoo AR dataset	The correlation between each sample probe and the gallery face is determined by using the sparse limit instance-to-class distance	Local feature representation, sparse representation based classification	Recognize an artificial facial patch to improve these systems' knowledge	Don't be prone to misalignments.
Face Recognition Under Occlusions and Variant Expressions With Partial Similarity [32]	Recognize non cooperative or even non cooperative subjects who seek to circumvent the recognition system by intentionally changing their facial appearance by tricks such as variation or mask	FERT dataset	Novel perception driven non-metric partial similarity test is adopted, which is potentially useful in addressing the issues involved because it can serve to identify the influential partial similarities that govern human perception.	Golden section rule and the maximum margin criterion	Matching rate as high as 98.0%	The usefulness of the proposed method is shown in the treatment of broad words, partial occlusions and other distortions
Robust Face Recognition via Sparse Representation [33]	Automatically identifying human faces with differing posture and lighting, as well as occlusion and camouflage from frontal images.	YALE B database, AR database	It helps in main two causes feature extraction and robustness to occlusion	Sparse representation classification	87.0% to 97.5 %	Could treat occlusion and leakage errors equally by exploiting the fact that the regular (pixel) source of these errors is often sparse.

Largest Matching Areas for Illumination and Occlusion Robust Face Recognition [34]	Handle uneven illumination, partial occlusion and limited training data	YALE B dataset AR dataset	lighting normalization, occlusion de emphasis and finally face recognition	LMA; Band-Pass Filtering for Preprocessing	LMAs average accuracy 99.62%	The importance of two factors in the success of the new method: the inclusion of an unseen data model and the finding of a (dynamic) LMA instead of a fixed size patch.
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**Conclusion**

Partial face recognition could be a troublesome job within the field of image process, machine learning, and computer vision. Few methods focus on partial face recognition. Research has been done in partial face recognition. Partial face recognition system has achieved a very efficient and effective outcome in an intricate environment. Partial face recognition using CNN offers a lot of preciseness in recognition system. To achieve a lot of sturdy lead to partial face recognition, there's a necessity for sturdy correlation among the computer vision, signal processing, artificial intelligence and machine learning

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