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SURVEY ON VARIOUS FACE DETECTION METHODS

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Abstract: Face detection and recognition are two important areas of research in computer vision that have received significant attention over the past few decades. With the increasing availability of image and video data, automated identification of individuals based on their facial features has become an essential task in many applications, including security, surveillance, human-computer interaction, and entertainment. This survey paper provides an overview of the state-of-the-art in face detection and recognition, focusing on the techniques and approaches used for automated identification of individuals based on their facial features. The paper first discusses the fundamentals of face detection, including the challenges involved in detecting faces in real-world images and videos, such as varying illumination conditions, occlusion, and pose variations. Further, the paper also presents an in-depth analysis of various methods employed in face detection, including traditional techniques such as Viola-Jones, as well as more recent deep learning-based approaches such as Convolutional Neural Networks (CNNs). Finally, the paper concludes by providing insights into future directions for research in face detection and recognition.

Index Terms **– Viola-Jones, Yolo, GAN, RetinaNet, MC-KCF algorithm, Resnet, N-FPN module.**

I. INTRODUCTION

The development of face detection and recognition algorithms has been fueled by advances in computer vision, machine learning, and artificial intelligence. In the past, face detection and recognition were considered to be challenging tasks due to the variations in lighting conditions, facial expressions, and occlusions. However, with the recent advances in deep learning, these challenges have been addressed to a large extent. The use of face detection and recognition has become increasingly common in our daily lives. For instance, we use face recognition to unlock our smartphones, tag people in photos on social media, and for security purposes in various applications. In addition, face detection and recognition technologies have been used in criminal investigations to identify suspects and in healthcare for diagnosing medical conditions that manifest through facial features. Despite the numerous applications of face detection and recognition, there are still several challenges that researchers and developers need to overcome. One of the challenges is dealing with occlusions such as glasses, hats, and masks. Another challenge is addressing the issue of privacy concerns as the use of face recognition technology raises ethical questions. Furthermore, there is a need to develop algorithms that can accurately detect and recognize faces from low-quality images or videos. The purpose of this survey paper is to provide an overview of the state-of-the-art techniques and algorithms used in face detection and recognition. The paper will also present a comparative analysis of various face detection and recognition algorithms, their strengths, and weaknesses. Overall, this survey paper aims to provide readers with a comprehensive understanding of the current state-of-the-art techniques in face detection and recognition.

II. BLOCK DIAGRAM

Face-detection algorithms concentrate on identifying human frontal faces. It is comparable to image detection, where an individual's image is matched piece by piece. Images are compatible with those kept in databases. The database's matching process will be rendered useless if any face feature changes occur. By using a combination of computer vision algorithms and machine learning techniques, these tasks can be performed accurately and efficiently. A face detector typically consists of several stages or components that work together to detect faces in an image. The general block diagram for a face detector may include the following components:

Image Acquisition: This component is responsible for acquiring an image containing faces. The image can be obtained from a camera or a file. *Pre-processing*: This component is responsible for preparing the image for detection by applying operations such as resizing, normalization, and colour space conversion. This step can also include removing noise from the image to improve the accuracy of the face detection algorithm. Feature Extraction: This component is responsible for extracting features from the pre-processed image that can help identify the location of faces. Common features include edges, colour gradients, and facial landmarks. *Training sets:* It is a key component of machine learning algorithms which consists of a collection of data samples that are used to train a machine learning model. *Face Database:* It is a collection of images or videos that are specifically designed for use in training and testing face recognition algorithms. These databases typically contain images of human faces captured under different conditions, such as varying illumination, pose, and facial expression, as well as different demographics, such as age, gender, and ethnicity. *Classifier:* This component is responsible for classifying the extracted features as either face or non-face. This is typically done using a machine learning algorithm, such as a Support Vector Machine (SVM) or a Convolutional Neural Network (CNN).

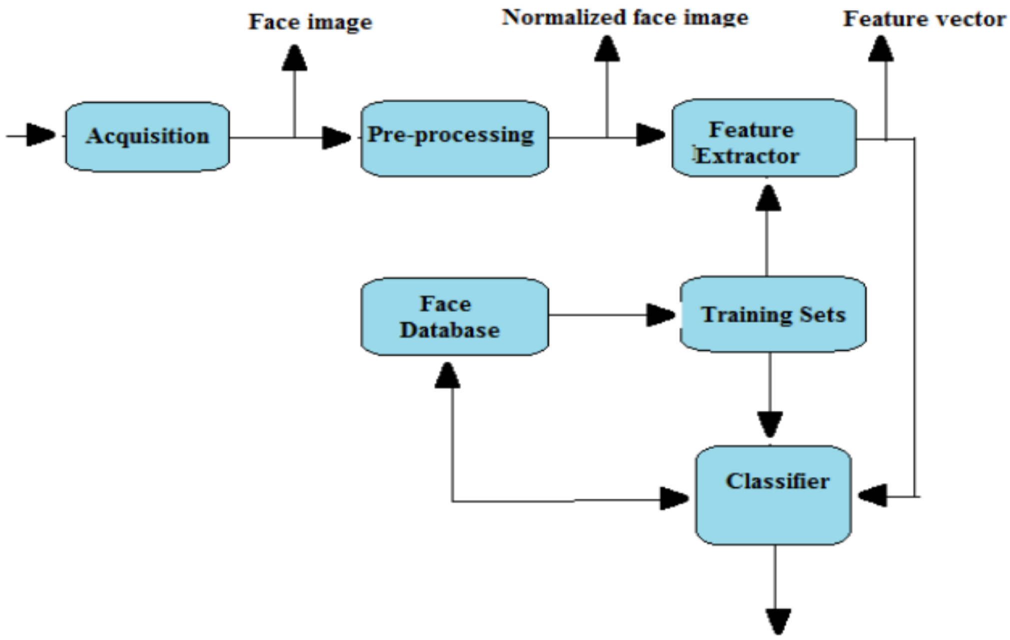

Fig.1 General Block Diagram Representation of Face Detection Model [11]

III. LITERATURE SURVEY

Wenqi Wu et.al. (2018) [1] proposed a different scales face detector (DSFD) based on Faster R-CNN. Here, A multitask RPN that extracts the high quality face proposals is concatenated with parallel type Faster R-CNN which consists of three networks that works based on the proposal scales. This new network has achieved an AP of 98.12% and recall rate of 93.51 on Large Scale Faces while performing as real-time a Faster R-CNN.

Shifeng Zhang et.al. (2019) [2] presented a single-shot Refinement face detector named RefineFace which uses five modules namely Selective Two-step Regression (STR), Selective Two-step Classification (STC), Scale-aware Margin Loss (SML), Feature Supervision Module (FSM) and Receptive Field Enhancement (RFE) to increase the performance of the detector. This method achieves state-runs at 37:3 FPS with ResNet-18 for VGA-resolution image and the best AP performance of about 92% in hard subset for validation set, and 91.4% for testing set. Thus it outperforms all compared state-of-the-art methods based on the average precision (AP) across the three subsets.

WANGHUA DENG et.al (2019) [3] proposed a system called DriCare which detects the drivers' fatigue status, such as yawning, blinking, and duration of eye closure, using video images, without equipping their bodies with devices. This method uses MC-KCF algorithm to track the driver's face and recognize the facial key regions based on key-point detection. For detection accuracy, illumination enhancement method and histogram equalization (HE) algorithm is used to preprocess and improve the brightness of the image frame. This method achieved around 92% accuracy.

Ali Khodabakhsh et.al (2020) [4] proposed a Generalizable Deepfake Detector based on a Neural Conditional Distribution Modelling. Deepfakes are a category of synthetic face generation methods and
are commonly based on GAN. This article demonstrates a novel two-step synthetic face image detection method in which general-purpose features are extracted in a first step, minimizing the task of detecting synthetic images. The detector predicts the conditional probabilities by observing every individual pixel in the image and is trained on pristine data only and shows only minimal loss in performance with regard to detection of synthetic samples.

Anitta George et.al (2020) [5] proposed a method that uses Generative Adversarial Networks to identify targets even with slightly different facial features, including hair colour, eye colour, facial hair structure, etc. GAN uses two different neural networks called

Generator and Discriminator in which Generator can generate more realistically fake images with slightly tuned features and the discriminator will extract features which further generate the corresponding identity code of the target from the database. The accuracy of the system is directly proportional to the number of epochs trained in the network.

Weijun Chen et.al. (2020) [6] proposed a face detector named YOLO-face based on YOLOv3 to improve the performance for face detection. This approach uses anchor boxes more appropriate for face detection and a more precise regression loss function. The improved detector significantly increased accuracy while remaining fast detection speed. The detector increases the performance by more than 50% when compared to other traditional algorithm and is considered as the best detector before.

Sayan Deb Sarkar et.al. (2020) [7] presents a face recognition that proposes a hybrid model combining the output from two different ANN called PCA-ANN and LDA ANN. In this approach, feature extraction techniques are applied using interest point and edge detectors namely, Harris, SIFT, Canny and Laplacian of Gaussian. Principal Component Analysis and Linear Disciminant Analysis are the two linear transformation techniques used for dimensionality reduction of the extracted feature vector. Considering two such different representations, we have trained the model using an artificial neural network and finally combined the result using a logical OR operation. The proposed approach achieves 98.5% accuracy on Faces94 and outshines DeepID and Light CNN-9 approach.

MengAn Shi et.al (2021) [8] suggested a quick target identification technique that was enhanced by YOLOv4. In addition, the backbone feature extraction network CSPDarknet53 has been modified to MobileNet and GhostNet as the backbone. Using WIDER FACE, a sizable open data set of human faces, the most effective backbone feature extraction network was chosen. The k-means++ technique is used to construct a new face prediction bounding box at the same time, taking into account that the scale direction of the face is changed when it is detected, in order to speed up convergence and enhance detection accuracy. According to the experimental findings of this work, the original accuracy is maintained to satisfy the demands of human face detection while the network parameters and computational effort are significantly lowered when compared to the original approach.

Chenchen Jiang et.al (2022) [9] suggested an enhanced RetinaNet (IRNet) model for face detection. Feature fusion modules are a popular approach for dealing with multi-scale detection issues in the face detection sector. This work introduces the N-FPN, a new feature fusion module. It has been demonstrated that the N-FPN module increases detection precision. To choose the best weight decay parameters, we design tests. In the Easy, Medium, and Hard datasets of Wider Face, the IRNet eventually achieves 91.77%, 89.26%, and 76.59% detection results, respectively. This enhanced IRNet outperformed RetinaNet using the FDDB dataset in terms of detection outcomes.

Yuquan Zhou et.al (2022) [10] proposed a new model to deal with the problems caused by varied illumination angles and uneven illumination distribution that will definitely have some effects on the detection of human faces when it comes to face detection. This research proposes a novel framework for an infrared facial recognition algorithm based on the YOLOv5 framework in light of the aforementioned situation. Due to the tiny size of the indoor face dataset, the post-training model frequently overfits the training set's features, which reduces generalisation ability and causes other issues. Homomorphic filtering is employed in this case to expand the small data sets. After that, the YOLOv5-based infrared face recognition model is trained. The detection model, which can adapt to detection tasks under diverse lighting conditions, has an accuracy of 93.55% and an F1-Sore of 87.37, according to experimental results.

Author and Year of Publication	**Title of the work**	**Technologies Used**	**Inferences**
Yuquan Zhou et.al(2022)	Face Detection With Different Scales Based on Faster R-CNN.	YoloV5	Adapt to detection tasks under diverse lighting conditions. Achieves accuracy of 93.55%
Chenchen Jiang et.al(2022)	RefineFace: Refinement Neural Network for High Performance Face Detection	Enhanced RetinaNet(IRNet) N-FPN module	Accuracy and Precision is above 99%.
MengAn Shi et.al (2021)	Real-Time Driver-Drowsiness Detection System Using Facial Features	Yolov4(face detection), MobileNet and GhostNet(feature extraction)	Less Computational effort and better Accuracy

Sayan Deb Sarkar et.al. (2020)	A Generalizable Deepfake Detector based on Neural Conditional Distribution Modelling	Yolov4 Algorithm	Achieves 98.5% accuracy on Faces94 and outshines DeepID and Light CNN-9 approach.
Weijun Chen et.al. (2020)	Criminal Face Recognition using GAN.	Yolov3	Improved Accuracy Fast detection Speed
Anitta George et.al (2020)	YOLO-face: a real-time face detector	GAN(Generative Adversarial Network)	Identify targets even with slightly different facial features,
Ali Khodabakhsh et.al (2020)	Face Recognition using Artificial Neural Network and Feature Extraction.	GAN based Deepfakes	Detects synthetic images. Minimize the loss of performance in detecting synthetic images
WANGHUA DENG et.al (2019)	Lightweight real-time face detection method based on improved YOLOv4	MC-KCF algorithm	Achieves accuracy of 92%
Shifeng Zhang et.al. (2019)	IRNet: An Improved RetinaNet Model for Face Detection.	ResNet-18	This method achieves state-runs at 37:3 FPS. Better AP Performance.
Wenqi Wu et.al. (2018)	A novel YOLO V5 framework for infrared image recognition	Faster R-CNN	Acheives good AP of 98.12% and recall rate of 93.51% on Large Scale Faces

IV. CONCLUSION

Face recognition and detection technologies have emerged as an essential tool for a wide range of applications, including security, surveillance, and biometric authentication. The advancements in deep learning algorithms, computer vision techniques, and hardware processing capabilities have significantly improved the accuracy and efficiency of face recognition and detection systems. Moreover, the survey results also highlighted the need for ongoing research and development to enhance the performance of these systems, particularly in challenging scenarios, such as low light conditions, occlusions, and pose variations. Synthetic face generation technologies have significant potential to benefit society in various ways, but it is essential to address the ethical and legal concerns associated with their use.

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