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Landmark Points Detection in Case of Human Facial Tracking and Detection

Anita Jindal, Rashmi Priya

***Abstract:** This paper describes the human facial landmark points detection is very important in the field of image processing as face detect, face identifies, face re-construct, face corners alignment, different head pose and facial expression analysis. Facial landmark is an essential point for applying face processing operation ranging from biometric recognition to mental states. In this paper, Haar cascading face detection technique is used to face detection and tracking. Histogram of Oriented Gradients (hog) has been used for 68 landmark points detection in case of human tracking and detection and support vector machine (svm) classifier are used for 68 landmark points detection for right-left eyebrow, left-right eye, nose, lips, chin, and jaw. The existing methods work effectively but many issues occur in detection as of different head poses, facial expressions, facial occlusion, illumination, colour, shadowing and self-shadowing etc. The performance of experimental results shows the advantages of our purposed method is highly accurate in terms of facial 68 landmark points tracking and detection and less error detection rate with the Multi-PIE database.*

***Keywords:**Face detects, Face tracking, Human Facial 68 landmark points detections.*

I. INTRODUCTION

The last three decades, there is an increase in the demands of research in automatic facial landmark points tracking and detection system in the area of image processing. The human face detection and landmark points detection plays a vital role in facial expression analysis, faces animation, 3-D faces re-construction, registration, face recognition, face tracking, and head gesture understanding. Face identity in digital photo, image editing software for facial, lips reading, sign language isthe application area of landmark points detection. Landmark detection systems use algorithms of image and video analysis. Face landmarks are the detection and localization key point on a face. These are classified into two types namely primary landmarks and secondary landmarks. First landmark points such as mouth, corner of the eyes, nose tips, and left-right eyebrow can be detected by using low-level image featurer detect and the secondary landmark points such as chin, cheek, mid-points of lips, nonextremity points and nostrils. These points are essential for recognising facial expression. The Haar cascading method works implicitly captures information about the appearance and facial shape. This model calculates features and predicts the displacement vectors for a few sample patches in testing. Support vector machine (svm) classifiers are trained to learn about the appearance model. In the above-stated models, initially, a face is located by analyzing the skin colour. Now, these automatically extract features from a face such as accurate detection and tracking of locations of landmark points facial features such as eyes, nose, and mouth. The extracted features reveal detailed information about human facial features. These models are useful for developing the applications for a surveillance system, smart tracking of moving objects, automatic target recognition systems [1]. The model proposed in [7] makes effective use of the convolutional neural network (CNN) a dominant deep learning model. The CNN cascaded model is used to detect and track human 68 landmark points. Nowadays, the researcher is focusing on the problems of detection challenges of uncontrolled conditions, in which facial images are tested face expressions, different head pose, illumination, occlusions etc.

In this paper, author describes a real-time facial 68 landmark points detection system. It is the combination of HOG features and a classifier for an image pyramid and moving window detection using the Dlib library. We used the Open CV library for image processing in feature extraction. The whole method was tested on the extended MultiPIE face dataset. In this method, an image is divided into small connected grids and for all the grids, the gradient is calculated. Then local histograms are determined from these gradients and combining these histograms a descriptor is formed. Finally, a linear SVM is used to detect faces. After detecting faces, the face area is cropped and resized to make all the images have the same size. The main challenge of the method was to detect the subtle changes in features in a fatigued face. This classifier gave an overall accuracy of 98.44 % and the error rate is 1.56 %.

II. BACKGROUND AND RELATED WORKS

The study of existing methods of tracking and detection literature revises that there are many techniques that are used for the detection of human facial landmark points. In Table 1, we describe the classification of existing techniques on the parameters of contributions, algorithms used for tracking and detection, advantages of the technique, disadvantages, data collection and experiments results.

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* Correspondence Author
Anita Jindal*, DEEE department, G D Goenka University, Gurgaon, India. Email: anita.jindal@gdgoenka.ac.in
Dr. Rashmi Priya, CSE department, G D Goenka. University, Gurgaon, India. Email: Rashmi.priya@gdgu.org

Sr. No	Focus of research and year	Algorithm	Advantages	Disadvantages	Data collection	Result
1	SNOW classifier Performed together with pixel information of an images and further implemented. The second Phase is Face detection [2014] [14].	SNOW Classifier Method	Able to detect with illumination and sensor Variation in Detection. The face detection speed is high. The Standard Snow classifier. Computationally Efficient	Varies less as compared to brightness includes regions that contain very similar togray values regions that are present in an image which might detect them as face.	Requires just training data.	Object Detection rate is 66%
	A neural network based on the front face Detection system. A rationally attached neural Network examines small windows of an image and each window contain a face [2014] [14].	Neural Network-Based Face Detection.	The satisfactory number of face detections. Acceptable False detection.	The detection process is slow due to train the non-face window. The result is not accurate. The methodology is complex. Less computationally, expensive.	Faces in a set of 131 test images.	Detection Rate between 78.9% and 90.5%.
2	Study 6 most popular face detection algorithms [2016] [17].	Face Detection using Eigen Faces Approach.	Face detection is highly reliable.	Computational complexity It is hard to implement in real time.	21 images for the varying number of Head poses in	The detection rate is 3.5 seconds and accuracy is about 90.50 %. Recognition rate O(m2n2) Where m, n are row and column of the image matrix
3	Effectively used to detect the similarity of two Binary images [2016] [17].	Hausdorff Distance-Based Face Detection	Effectively used to detect the similarity of two binary images.	Restricted into two Dimensions	Different test sets.	Recognition rate O(n+m) time. Where m, n are rows and columns of image Matrix Detection Rate 60% - 90%.
4	Closeness is defined in terms of distance learning of distance where Distance Between two features [2016] [17].	K-Nearest Neighbor Classification	Improves face Detection process. The similarity between two samples using Euclidian distance that is the distance Between Two samples is, get a higher similarity.	Processing time is slow.	Test image is compared with every instance of training data using above Euclidian distance.	O(mn) Where m, n are rows and columns of the Image matrix.
5	The haar method is used to determine light and dark area in the group pixelsincreasing or decreasing the size of the pixel group being examined [2016] [17].	Facial feature detection using The Haar classifier. Used Edge features,Line features, and center surround features.	It used detected features for object detection. Two set of date are used for detection positive and negative of sizes of data	Frontal face detection, Extremely Long training time, Limited head poses.	Only two set of images are required to train the classifier.	Object detection time is O(N+T) where N is the total number of samples are used for detection and T is the total features.

6	Face detection technique two techniques are used model base is also known as shape-based method which consider face and facial landmark points as whole shape. The second method is based on type, texture the aim to search landmark points without guidance of a model [2016][6].	Support vector machine trained on DCT features of each landmark points.	Reduce the time for search a point location. Increase the accuracy and robustness of algorithm.	Not able to detect face in the compound factors such as head pose, occlusion and illumination.	Under controlled condition data base used as Multi-Pie, XM2VT, FRGC V2, AR, and Uncontrolled conditions object detection the data base is used like LFPW, HELEN, AFW, AFLW, IBUG.	Landmark points detection (68,68,5,22 and 35,194,6,21,68)
7	A fatigue detection method based on changes in the eye and mouth region using facial landmark points Detected 62 facial landmark points [2018][7].	Histogram oriented Gradients (hog) are used for face detection and support vector machine (svm) is use as the classifier.	To subtle changes in features fatigued in A face in which respect the method Achieves A Satisfactory level of success.	Need to explore smarter approaches for Higher accuracy, especially from more realistic datasets. A lack of datasets.	Cohn-Kanade Dataset and Psychological image collection at Sterling dataset.	This classifier gave an overall accuracy of 82.79%.
8	The holistic methods are used to represent the global facial object Features and shape information [8].	Active appearance Model algorithm. Principal Component analysis.	Performance is poor in detection and the detection time is high	Whole face explicit poor generalization/good slow	Undergo varying Facial expressions, head poses, illumination facial occlusion Bio-id, Ar, Extended YaleB, FERET, CK or CK+, MultiPIE, XM2VTSDB,FRGC V2, BU-4DFE,Uncontrolled AFLW, LFPW,Helen, AFW, I-bug, COFW.	Landmarkdetectionpoint(20,22,3,11,68, 68,68,68,68 and21,29,168,6,68,38,29).
	The CLM method is used the global shape of model but used the local appearance model.	HOGfeatureDetection andtrackingandSVM classifier.	Performance isbetter than aholistic method.Generalization. Slow.	Localpatch,explicit,good, slow		
	The Regression basedMethod is implicitlycapture faceshape and appearance pixelinformation [2018] [8].	The regression-based methods directly used the mapping from imageappearance to the facial landmark points	Only need to calculate the features points andpredict displacementvector for a fewsamples' patches intesting. Moreefficient.	Face detection goodand fast.		

THE PROPOSED SYSTEM

In this paper, the author is proposed a real-time method to perform face detection using Haar cascade technique. The system makes effective use of Open CV library for image processing and dlib library for feature extraction. Histogram oriented gradients (hog) based approach is applied to detect and track facial 68 landmark points. The system is based on to detect the right-left eyebrow, left-right eye, right eye, nose, lips, chin, and jaw for extracting landmark points. The system measures distances between landmark points. These distances are fed as a feature set into the support vector machine(svm) classifier. Figure 1 shows the flow of working in the proposed system.

The system follows the following step to operate facial landmark points tracking and detection.

Step 1: A real-time videos capturing using the raspberry pi camera.

Step 2: Converts a video into frames.

Step3: Face detection using Haar cascade algorithm.The algorithm identifies whether a face is existing in an image, if a face does not exist in the image, then it searches the face in subsequent images.

Step 4: Conversion of Image into Histograms (hog) method converts an image into a series of histograms based on the orientation and magnitude of pixel gradients within the image.

Step 5: Detection of facial features using facial landmarks.

Step 6: Successfully tracking a face.

SVM Classifier is trained with a huge database of images for achieving more accuracy. Open CV uses two types of classifiers, local binary pattern (LBP) and Haar Cascades

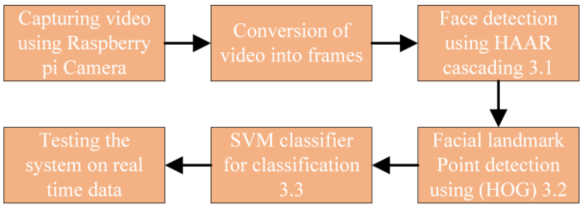

Fig3. Flow diagram of Facial Features' Detection and Tracking.

method. The LBP successfully performs the detection of moving objects by background subtraction. However,LBP is not sensitive to small changes in face localization. It is only used for binary and grey images. A Haar cascade method is based on the Haar wavelet technique to analyse pixels in an image into squares. Haar Cascades uses the Adaboost algorithm to detect the face in the image as well as in the video. Haar cascade method is more accurate and faster to detect the images and videos.

A. Face Detection

In this paper, the author is used the Haar Cascading method to identify whether a face is in the images or not. If the face does not in the image, then again from the starting and if the face is in an image. Face localization is the process of finding whether a face is included in an image, and its location and size. Due to the use of different features, find out the facial localization has a different method. The facial edges have been used to find the facial localization, facial texture information is also used for facial localization, facial localization have been found out using a facial greyscale. Skin colour has an important property, it is in a relatively independent position in the colour space, skin colour information is used to find out facial localization. An image pyramid and moving object detection window are used dlib library. The Dlib library is based on face detector performance of all of the Open CV variants with good accuracy and detection error is low positives when capture the real-time images and videos in uncontrolled environments, like high gender and face interpersonal variation, different changes in head pose, facial feelings, head position, and from control conditions such as lighting, image resolution.

B. Facial Landmarks Detection

The aim of the proposed method to find automatically face and facial 68 landmark points detection. To find landmarks on a face, a shape estimator implemented in the dlib library [4, 5] is used. The facial 68 landmark points are shown in Figure 2. The facial landmark points are arranged in two main classes primary and secondary. The first landmarks are

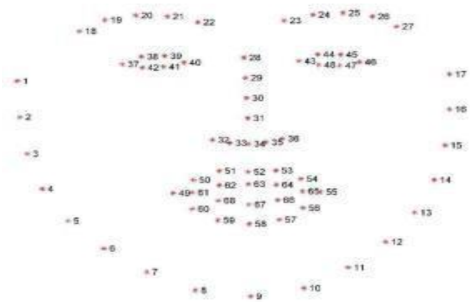

Fig.1. Facial 68 Landmark Points

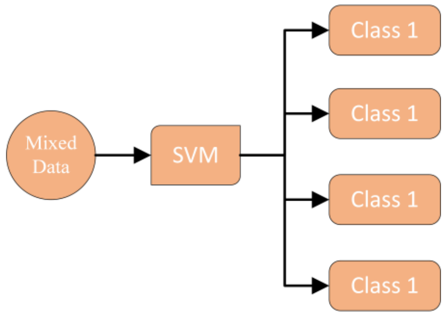

Fig.2. SVM Classifier

directly detected landmarks, such as mouth, eyes, nose, and eyebrows. These play an important role in facial identities from low-level image features. The secondary landmarks points are chin, cheek, left-right eyebrow and lips, non-extremity points and nose. These are important in identifying facial expression and face tracking. The whole method was tested on the extended Multi-PIE face dataset.

C. SVM Classifier

Support vector machines (svm) is the multi-class support vector method that looks into the data and sorts it into one of the two categories as classification and regression as shown in Figure 3. SVM has been used for face detection, and landmark points detection and detected landmarks point are classifying into the different categorization, such as mouth, eyes, nose, and eyebrows chin, cheek, left-right eyebrow and lips. Advantages of SVM has high dimensional input space and regularization parameter. Support vector machines are used to the classification of facial expressions in both still images and live video.

III. DATABASE "UNCONTROLLED ENVIRONMENTS"

Facial 68 landmark points detection algorithms aim to detect 68 points in different environmental conditions.

The facial images are taken within controlled conditions and uncontrolled conditions. But in the real world, human facial images are captured in different facial expressions, head poses, illuminations, facial occlusion illumination, colour, shadowing, self-shadowing, low resolution etc. Thus, researchers focus on the challenging "in-the-wild" that's uncontrolled conditions [6].Authors performed the experiments on control and uncontrolled condition using multi pie databases. Multi-pie database is containing more than 750,201 face images of 339 subjects. The facial images are taken under 17 viewpoints and 21 illumination conditions. Some facial feelings are included, such as neutral, happy, sad, surprise, squint, disgust, and fear. 68 facial landmark points are depending on the different head poses, facial expressions, occlusion, and illumination variations.

IV. EXPERIMENTS RESULTS AND DISCUSSION

The author performed these experiments on the set up as Raspberry Pi 3 connect with power supply, mouse and keyboard. The HDMI cable is connected with the system as well as a projector. The output is displayed on the projector screen. Also, we can use the TV or laptop screen to display the output. Raspberry Pi camera is used to captures real-time videos and images in different conditions like 580 images are tested over different head poses up- down and extremely lift and right head, the proposed system is also evaluated for detection and tracking of the different head. The results indicate that the system is effective in the tracking of all the facial landmark points for different head pose orientations.

The system is evaluated for different occlusions such as spectacle, hats etc. The experimental results yield the accuracy of 100% in the detection of the facial points. The system is successful in tracking and detecting the facial landmark points in real scenarios such as a person is drinking or eating. The experimental results are shown in figure 4.

The evaluation of system real-time images with various facial expressions such as anger, fear, happiness, sad, surprise, disgust proves its effectiveness by giving 100% accuracy in tracking and detection of facial landmark points in all the cases the results are shown in figure 5.

A. Result Analysis

Table II shows the available different database which is used are both control and uncontrolled environmental conditions with how many landmark points detect, accurate facial landmarks points detection rate and error detection rate in percentage.

B. EVALUATIONS

The efficacy of the SVM algorithm is tested on 580 real-time images and videos overextended Multi-Pie database. Experiments have performed over various conditions like controlled. The results are shown in Figure 7. and uncontrolled conditions such as different head poses, facial expressions, occlusion, illumination and low resolution etc. The results are shown in figure 8. The experimental results have proven that the proposed system is successful in tracking and detection of real-time facial landmark points over 580 images and just 9 images which are extremely high and side faces are not able to detect. The system is conceptually simple, effective and accurate is 98.44 % in terms of very low variants with greater accuracy and error rate is 1.56 % are shown in the Fig.8. and uncontrolled environments the results are shown in Fig.10.

C. LIMITATIONS

The proposed system was tested on different set of real time images and videos for tracking and detecting on 2D and 3D facial landmark points for different facial expressions, head poses, illuminations, occlusion,
illumination, colour, shadowing, self-shadow and low resolution etc. Also, the system is tested successfully for the various real time facial images having various occlusions.

Fig4. Facial features tracking and detection in different occlusions

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Fig5. Facial features tracking and detection with different facial expressions

Table- II: Different database which is used are both control and uncontrolled environmental conditions

Database	Totalimages	Subject	Number of landmark points	Image	Imaging capture conditions	Landmark points detection rate %	Errors rate (%)
FERET [20]	14127	1563	-	Colour	Controlled	92.43	7.57
XM2VTS [21]	2361	296	68	Colour	Controlled	92	8
JAFFE[22]	213	10		Gray	Controlled	93.7	6.3
PUT [23]	9971	100	30	Colour	Controlled	78	22
ORL [24]	400	10	-	Gray	Controlled	95.5	4.5
IMM [25]	240	40	58	Colour	Controlled	87.28	12.72
MUCT [26]	3755	276	76	Colour	Controlled	85	15
MUG [27]	401	26	86	Colour	Controlled	91.7	8.3
CAS-PEAL[28]	99594	1040		Gray	Controlled	92.4	7.6
Bio-id [32]	1521	24	22	Gray	Controlled	92	8
AFLW [29]	25992	–	20	Colour	Uncontrolled	93.5	6.5
Yale B [30]	5760	10	–	Gray	Controlled	81.2	18.8
AR [33]	4000	126	130	Colour	Uncontrolled	96.8	3.2
300-W [30]	399	300	68	Colour	Uncontrolled	91.7	8.3
Multi-PIE	750000	337	68	Gray/ Colour	Controlled/ Uncontrolled	98.44	1.56

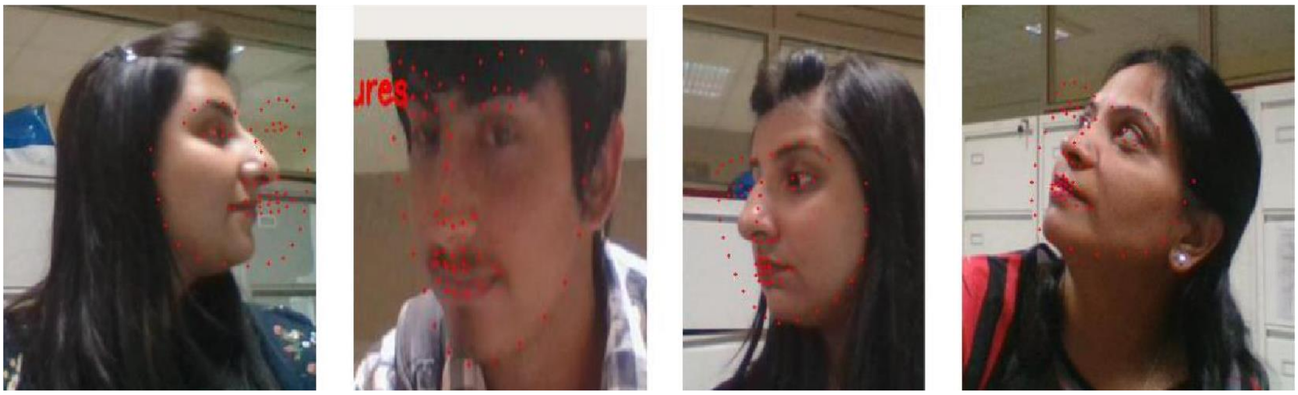

Fig.6. Limitation

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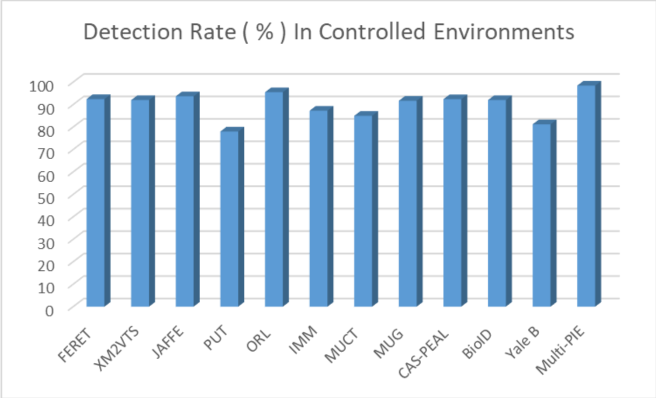

Fig.7. Facial tracking and detection rate (%) in controlled environments

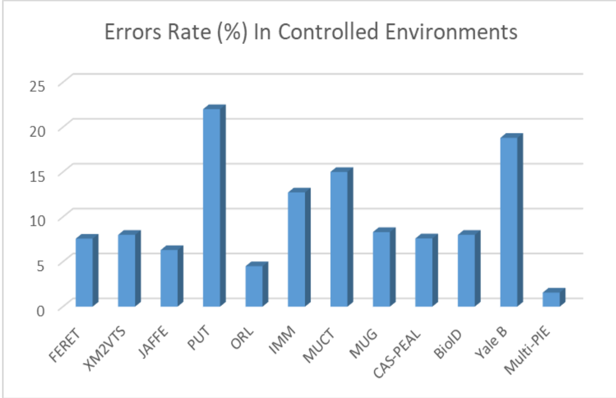

Fig.8. Facial detection error rate (%) in controlled environments

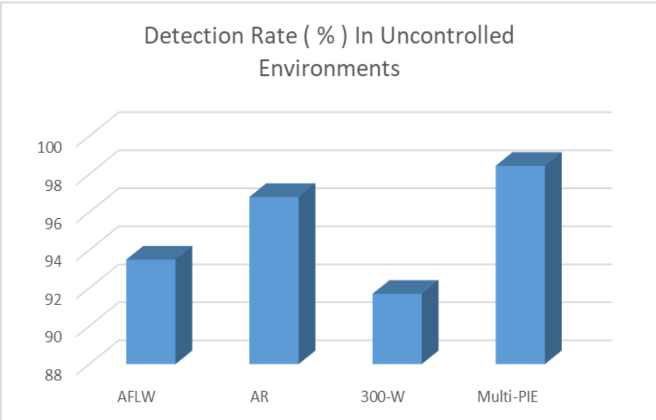

Fig.9. Facial tracking and detection rate (%) in uncontrolled environments

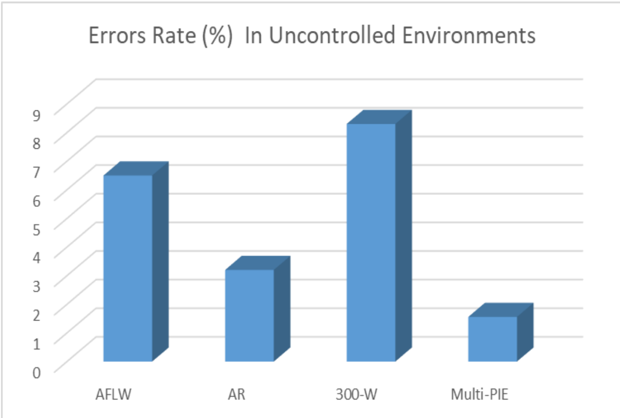

Fig.10. Facial detection error rate (%) in controlled environments

However, the system is unable to detect the facial landmark points for extremely left or extremely right head orientations accurately. The system is ineffective in tracking and detecting facial landmark points for the extremely high head poses the results are shown in fig. 6.

V. CONCLUSION

In this paper, the Haar cascading method is used to detect real-time facial images and videos. The hog is used for landmark points detection. The SVM classifier is used to classify the detected 68 landmark points such as corners of mouth, eyes, nose tips and left-right eyebrows, chin, cheek and lips midpoints. The efficacy of the SVM algorithm is tested on 580 real-time images and videos overextended Multi-PIE database. Experiments have performed over the various conditions like controlled and uncontrolled, 'in-the-wild' conditions such as different head poses, facial expressions, facial occlusion illumination, and low resolution etc. The experimental results have proven that the proposed system is successful in tracking and detection of real-time facial landmark points over 580 images and just 9 images which are extremely high and side faces are not able to detect. The system is conceptually simple, effective and accurate is 98.44 % in terms of very low variants with greater accuracy and error rate is 1.56 % fewer false positives. Both the Dlib and OpenCV face detectors performed better when applied to images from uncontrolled environments.

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AUTHORS PROFILE

Anita Jindalperceiving Ph.D. G D Goenka University, Gurgaon, India. M.E Computer Science, Mumbai, India. B.E. Electronics communication, Jalgaon, India. Research area Image Processing.

Dr. Rashmi Priya Ph.D. Computer Applications from Teerthanker Mahaveer University, Moradabad, India. MCA with Distinction from West Bengal University of Technology. BSc Mathematics Honours from North bengal University. Research area Distributed Computing.