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POSE VARIANT FACE DATABASE OF PUNJABI POPULATION

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ABSTRACT

Recognition of faces from the footages recorded by surveillance systems has been hyped up globally. Nowadays, forensic experts are dealing with numerous cases related to face recognition; nevertheless, due to the unavailability of a well-defined system and databases, most cases become futile in the court of law. The field of face recognition is one of the most active areas for researchers and is a challenge that scientists are exploring. Continuous research is being carried out in this field to design a variety of algorithms that could achieve higher accuracies in a short span of time. In order to check the robustness of their newly generated algorithms, researchers often require different types of human face databases. Various databases of human facial images captured under different illuminations, poses, occlusions, expressions, and populations are already available in the field. In the present study, an attempt has been made to create a database of 200 high-resolution colored facial images of Punjabi Jat Sikh individuals. The images have been captured by using a digital single-lens reflex camera with a uniform background, with and without accessories, and in five different orientations (poses). The results are expected to be useful for the researchers to evaluate the performance of their algorithms for comparing and identifying the human faces belonging to varied populations.

Keywords: *Forensic Science, Face Recognition, Database, Poses, Punjabi Population.*

INTRODUCTION

Face recognition is a biometric system involving pre-programmed techniques based on the analysis of physiological attributes such as face, iris pattern, and others for identifying individuals. Being submissive and inviolable, this technique is an exceptionally convenient approach to be used for the purpose of personal identification in cases of crime, and for commercial applications such as

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verification of licenses, identity proofs, and access control. It has also become a ubiquitous tool to guide the investigations, gather intelligence, and to act as evidence in the court of law (Jacquet and Champod, 2020.). As the field of facial recognition is multi-disciplinary; the active researchers working in different areas, namely computer vision, psychology, forensics, and pattern recognition, have now started working together under the same roof with a shared focus on developing a robust face recognition system with superior accuracy, sophistication, and sensitivity. Globally, the idea of facial dataset generation commenced with the onset of FERET dataset, which consists of 14,051 face images of more than 1000 individuals. This dataset has images with varied poses, illumination conditions, and facial expressions (Phillips, *et al*., 1998). Additionally, other available datasets in the public domain include, M2VTS Multimodal Face Database (Release 1.00) consisting of 185 images with varied poses and time, accessories, and speaking individuals (Pigeon and Vandendorpe, 1997); NIST Mugshot ID has 3248 images captured with frontal and side profiles (Watson and Flanagan, 2016); Oslo Face Database has 200 images of human subjects with neutral expressions and three gazing directions (The Oslo Face Database); UMIST Face Database includes 564 images of different human races and poses (Woodall *et al*., 2007); Yale Face Database A includes 165 images captured under varied illumination and expressions along with accessories (Belhumeur and Kriegman, 1998), and Yale Face Database B consists of 5760 human face images with varied illumination and poses (Georghiades *et al*., 2004).

Population Based Databases: A variety of face databases created from facial images of different populations are also present in the field of face recognition. Indian Face Database consists of 40 frontal face images of Indian human subjects (Jain, 2002). Senthil Kumar Face Database has 80 frontal face images of 5 Indian individuals with varied expressions, brightness, and occluded conditions (http://www.geocities.ws/senthilirtt/Senthil%20Face%20 Database%20Version1). 10K US Adult Face Database comprises of 10168 facial images with neutral face expressions and landmark point annotations of individuals having Indian Asian origin (Bainbridge *et al*., 2013). Similarly, Amsterdam Dynamic Facial Expression Set Database based on Northern European and Mediterranean population has 648 images with 9 varied emotions/ face expressions (Van Der Schalk, 2011). American Multiracial Face Database has 110 facial images with smiling and neutral face expressions of human subjects belonging to mixed race (Chen, 2020). Bogazici Face Database is based on Turkish population having 264 neutral expressions and presence of accessories (Aribay *et al*., 2018). Chinese Academy of Sciences-Pose Expression Accessory and Lighting (CAS-PEAL) Face Database is based on Chinese population with 99594 facial images, captured with varied expressions, Illumination, and poses, and accessories (Gao *et al*., 2008). Chicago Face Database consists of 597 face images with neutral facial expressions of four different populations namely Asian, Black, Latino and White (Ma *et al*., 2015).

Chicago Face Database-India Face Database consists of 142 facial images with varied face expressions of individuals belonging to Indian Asian origin (Lakshmi *et al*., 2021). Federation Equestre Internationale (FEI) Face Database comprises of 2800 face images with pose and appearance variations of Brazilian population (https://fei.edu.br/ cet/facedatabase.html.). Japanese Female Facial Expression (JFFE) Face Database has 213 facial images of Japanese women with varied face expressions (Kamachi *et al*., 1997). Mega-Resolution 2 Face Database (MR2) consists of 74 high quality, natural, diverse facial images of European, African, and East Asian population (Strohminger *et al*., 2016).

To carry out the task of evaluating the performance of face recognition algorithms, researchers often require a variety of different populations. Keeping this in mind, in the present study an attempt has been made to commence the creation of a face database of Punjabi population by taking good-quality-colored pictures of Punjabi individuals in five different orientations.

MATERIALS AND METHODS

For the purpose of creating Pose Variant Face Database of Punjabi Population (PPPV), a total of 200 images were acquired from 40 individuals. All the participants belonged to the Punjabi Jatt-Sikh population and majority of the subjects fall in the age group 18–28 years (Figure-1). A written consent was obtained from the subjects regarding the publication of their facial images. A Canon EOS 1300D camera with 18 megapixels was used to capture the images. The photography sessions took place in an open space in broad daylight. The camera was fixed on a Simpex tripod stand to prevent shaking while capturing the images. The distance between the camera and the subjects was maintained at 0.762 meters, as shown in Figure-2.

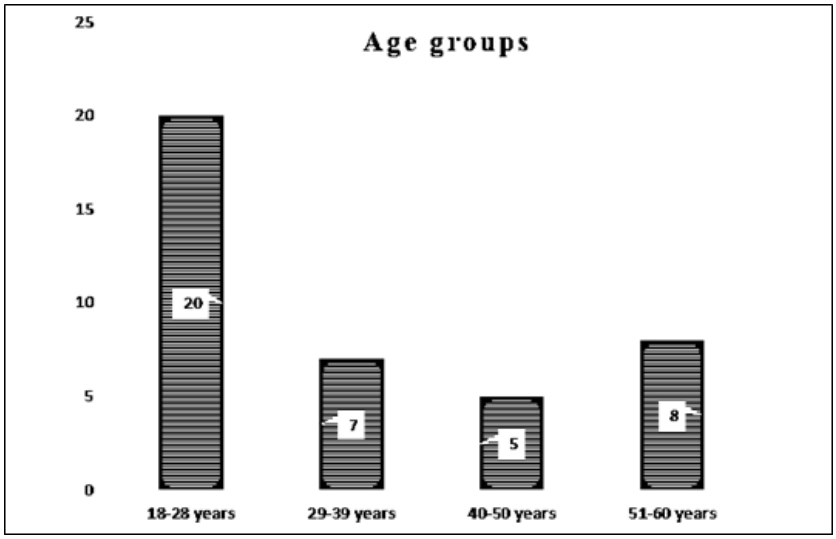

Figure-1: Bar graph demonstrating the different age groups

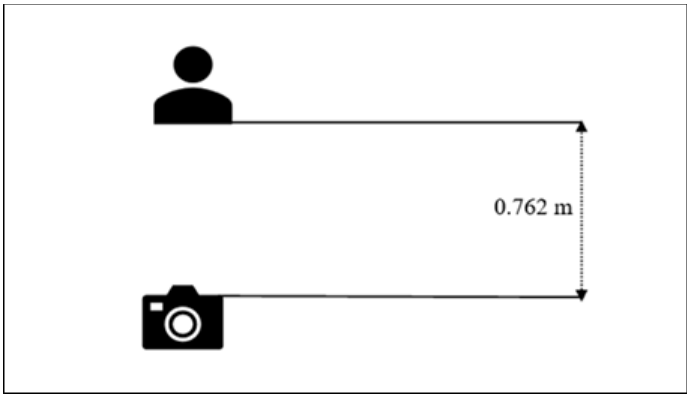

Figure-2: Sketch map demonstrating the distance between subject and camera

A protractor of size 2'×4' having degrees of angles ranging from 0° to 360° was prepared. The participants were asked to stand on it at five different angles 60°, 75°, 90°,105° and 120°, keeping their heads straight. The height of the camera corresponded to the height of the subject, capturing their whole face and neck region. A blue cloth was used as a background in order to extract the face images more clearly. All the Pictures were captured in natural daylight. There was no control over the facial expressions of the subjects involved and the accessories worn. Majority of the participants did not cover their heads, while some of them wore accessories such as shawl and turban as shown in Figures 4 and 6 respectively. The original pictures (5184×3456 pixels) were cropped to 1989×1933 pixels using MS-Paint 3D.

RESULTS AND DISCUSSION

The results are shown in the form of facial images constituting of front and side poses. The collected images have been saved in 'tiff' format in 40 different folders with sample numbers ranging from 1 to 40. Further, each folder contains 5 images per person, resulting in 200 images, in total. The degrees of angles marked on the protractor have been modified for easy demonstration as shown in Table-1. A total of 40 images at each orientation were collected as shown in Table-2.

Table-1: Degrees of angle modified for demonstrating orientations

Degrees of Angle	90°	105°	120°	75°	60°
Orientations	0° Front	+15° Left	+ 30° Left	-15° Right	-30° Right

Table-2: Count of images collected in different orientations

Orientations	0° Front	+15° Left	+ 30° Left	-15° Right	-30° Right
No. of images	40	40	40	40	40

Figure-3: Images of a female subject without head cover

Figure-4: Images of a female subject wearing a scarf as head cover

Figure-5: Images of a male subject with no accessory worn over head

Figure-6: Images of a male subject wearing turban as an accessory

To explain various poses in the figures, we can take the example of Figure-3. In this figure, filename 11_F.tiff means the sample number 11 is standing at a 0° angle, that is, in front pose facing the camera straight; 11_L1.tiff and 11_L2.tiff mean +15° and +30° (left side poses), respectively. Similarly, 11_R1.tiff and 11_R2.tiff mean -15° and -30° (right side poses), respectively. The same stands true for Figures-4 to 6.

The majority of face detection algorithms use certain characteristics, such as the presence of facial features, their size and shape, and skin color. The present database provides good quality-colored facial images in which the facial features such as forehead, eyes, nose, mouth, and chin are quite evident. The facial landmarks on these images can be clearly marked and the face dimensions can be accurately measured. Generally, a classic face identification method commences with the detection of skin-color-based areas, as the processing of color information is quicker than processing other facial attributes (Sharma and Reilly, 2003). Features, namely shape and skin color, is class characteristics of a particular population, and the generation of such population-based

databases is considered to be helpful for law enforcement agencies for the identification purposes. As mentioned earlier, these images are captured in a natural daylight, algorithms working on skin color can be benefitted from this database.

Validation of PPPV Face Database

The creation of this present database involves two steps. The first step involves the collection of facial images which is followed by the second step wherein the validation of collected images is carried out. The validation process involves the successful performance of any face recognition algorithm on the collected set of images. In the present study, facial features namely Full face, Eyes, Nose and Mouth were detected by using the Viola-Jones algorithm in MATLAB software in order to validate this newly created face database. The Viola-Jones method consists of three key elements: pre-processing of images, feature detection, and validation of features detected (Viola and Jones, 2001). The pre-processing step seeks to prepare the image for the face detection system by improving the image quality, removing the noise if present and segmenting the faces present in the input photos. The features of the input image are retrieved in the second step by using a Haar-like technique based on windows that contain human faces. The third step involves the Adaboost algorithm, which trains the face and nonface images provided in the database. Facial features such as a full face, eyes, nose, and mouth have been successfully detected from the collected images and are shown in Figure-7.

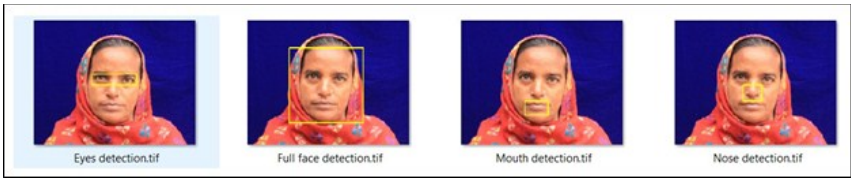

Figure-7. Facial feature detection results

CONCLUSIONS

For the present study, a database, entitled 'Punjabi Population Pose Variant' Face Database, has been generated and validated successfully. This database consists of 200 images of Punjabi Jatt-Sikh individuals that have been captured in five different poses at front, left, and right orientations. The protractor used for collecting images provides objectivity to the pose variations which was somewhat subjective in previously generated databases. The current database has been validated by using the famous Viola-Jones algorithm, developed for facial feature detection. The PPPV Face Database is the first one in the field which is based on the Punjabi Population. It will act as great facilitator for scientists working in the field of facial recognition to evaluate their face recognition algorithms involving population comparisons. In the future, a greater number of images belonging to Punjabi population will be added to this recently created face database.

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