Indian Face Age Database: A Database for Face Recognition with Age Variation

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ABSTRACT
Face recognition with age variation is a challenging task for researchers. In this research paper a new face database is proposed. The proposed name of this database is Indian Face Age Database (IFAD). It consists of images of Indian celebrities. To enhance the unconstrained age invariant face recognition research, a more challenging Indian Face Age Database (IFAD) is proposed and introduced that has much more variability compared to any other age variation face database. The database consists of 3296 faces of 55 known Indian celebrities collected from online sources. In IFAD face detection is done by Viola Jones face detection algorithm. This database has different phases of life of celebrities from childhood to old age. IFAD is a huge, real-world face database has 55 subjects and each has more than 50 images per subject. All images have large variation in age parameter and also have variation in lighting, expression and pose variation. The main purpose of IFAD is to show age variation. In proposed IFAD images are manually selected from online sources resulted in high degree of variation in scale, pose, expression, illumination, age, occlusion, makeup which one could ever see in natural world. IFAD is the first face database that provides a detailed annotation in terms of age, pose, gender, expression, amount of occlusion, for each face which may help other face related applications. The script of IFAD is written in MATLAB.

Keywords
Image processing, Feature extraction, Face recognition, Machine vision

1. INTRODUCTION
Recognizing an old met person or friend is an easy task for human beings. One can easily recognize a person from his biometric traits but in computer vision recognizing a person is one of the most challenging tasks. Human faces are complex and have no rigid structure. The face of a person changes with the passage of time. Automatic face recognition has very challenging tasks in pattern recognition (PR) and artificial intelligence (AI).

There are a large number of biometric traits that have been used for identity verification of a person. It can be any from face, iris, fingerprint, voice, handprint, signature, and retina. Out of all these traits face is one of the most popular traits because of its unique features. Identity verification using face recognition can be done without cooperation of the person concerned. It can be done without informing the person. Recognition of a person is becoming difficult under the variations of pose, illumination, occulation, expression etc. There are many proposed face database with different conditions like illumination, pose, occulation, expression and age. The age based face database till proposed do not have large variations of age. The recognition of face is dependent on a large number of factors which include pose, face expression, illumination, occlusion it may be partial or semi partial, hairstyle and age. To control these variations there are large number of algorithms developed which support these variations on different face databases. Based on these different factors there are large number of databases already exits. These face databases have been created in artificial environment. Images were taken under controlled conditions for each specific factor for creating face database. For example for pose varying face database different poses of a person were taken at different angles. All the images in that particular database follow same pose angles to each subject.

The main motivation of purposing Indian Face Age Database is to provide large set of variation with time. In this proposed IFAD there is large variation of age characteristic of a subject from childhood to old age. There is a series of phases of variation in appearance of face of an individual. Every subject shows variation in hairstyle, weight, skin texture etc. The proposed IFAD also shows variation in illumination, pose, occulation, expression. The purposed Indian Face Age Database (IFAD) is labeled face in wild database.

The rest of the paper is organized as follows: in section II review of existing popular databases are discussed. Section III age estimation for face recognition is discussed. In section IV face detection by Viola Jones is discussed. Section V describes the architecture of proposed IFAD. Section VI describes how to use proposed IFAD. The general statics of proposed IFAD are discussed in section VII. Section VIII concludes the proposed IFAD.

2. REVIEW OF EXISTING FACE DATABASES
There are large number of face database which already exist and are available for any researcher. Few of commonly used face databases are discussed below:

FERET database: Facial Recognition Technology (FERET) program and its development is sponsored by DOD counter drug technology program. The National Institute of standards and technology (NIST) is serving as technical agent for distribution of FERET database. The database images were taken in the semi-controlled environmental conditions. The same physical conditions were maintained to make the degree of uniformity throughout the database. The images which were taken on different dates have minor variations. The FERET database was collected in 15 sessions between August 1993 and July 1996. The database contains 1564 sets of images for a total of 14,126 images that includes 1199 individuals and 365 duplicate sets of images. A duplicate set called second set of images of subjects had taken on a

different day. For some subjects, images were taken at the gap of two years. Some subjects being photographed several times. The two years age gap causes change in a subject's appearance that was important because it enabled researchers to study, for the first time, changes in a subject's appearance that occur over a year [1].

Multi PIE: PIE face database is collected at Carnegie Mellon University in 2000. PIE database images contain pose and illumination variation of images for face recognition. It has more than 750,000 images of 337 subjects. Different images were taken under 15 view points and 19 illumination conditions. [2].

The Yale face database: Yale has 15 subjects and 165 images in total. Each subject has 11 images with different facial expression and appearances. It has grayscale images in GIF format. It has appearances like center-light, with glasses, happy, left-light, without glasses, normal, right-light, sad, sleepy, surprised, and wink. The Yale Face Database B has 5760 single light source images. The number of subjects is 10. It has 9 poses with 64 illumination conditions. [3].

ORL face database: It is one of the most popular face databases. It has 40 subjects and each subject contains 10 different images. The images were taken at different times, varying the illumination, facial expressions. Face expression has open or closed eyes, smiling or not smiling. Some subjects have different face details for example some wear glasses or no glasses. All the images were taken under homogeneous background with the subjects in an upright, frontal position [4].

Japanese Female Facial Expression (JAFFE) Database: JAFFE has images of Japanese female with seven facial expressions. Out of these 7 expressions, six are basic expression and one is neutral. It contains 213 images of 10 Japanese female models. [5].

Indian Face Database: The database was created at IIT Kanpur campus in February, 2002. There are forty subjects and each subject eleven different images. For some subjects, some additional photographs are included. The background of all images is bright homogeneous. The subjects are in an upright, frontal position. The images were in JPEG format. Each image is of 640x480 size, with 256 grey levels per pixel. The male and female images were placed in two main directories. In both directories, each subject has eleven different images. The database is orientation and emotion based variations. It has looking front, looking left, looking right, looking up, looking up towards left, looking up towards right, looking down orientations of the face. And neutral, smile, laughter, sad/disgust are the varying emotions [6].

Indian Movie Face database (IMFDB): Indian Movie Face database (IMFDB) is a large unconstrained face database consisting of 34512 images of 100 Indian actors collected from more than 100 videos. All the images are manually selected and cropped from the video frames resulting in a high degree of variability in terms of scale, pose, expression, illumination, age, resolution, occlusion, and makeup. IMFDB is the first face database that provides a detailed annotation of every image in terms of age, pose, gender, expression and type of occlusion that may help other face related applications [7].

Labeled Wikipedia Faces (LWF): The facial images and other important information are extracted for the Wikipedia Living People category. It has more than 0.5 million biographic entries and the number is continued to increase. LWF also have useful Meta data information e.g. the source images, image captions and person name detection results. Mining experiments can be performed on LWF. This is a unique property of LWF as compared to others. The LWF is a dataset with 8.5k faces for about 1.5k identities [8].

FG-NET database: The FG-NET is used by researchers for face recognition with age estimation or age detection. It contains face images at different ages. The database has been generated as part of the European Union project FG-NET (Face and Gesture Recognition Research Network). The database has two parts. Part A and Part B. Part A is ready for distribution whereas part B is still under development. It is expected that researchers who receive Part A of the Database will also contribute a number of images to Part B, in order to increase the number of images in the database. [9].

The study of all these existing databases show that there is no popular and easily available database which shows age as varying parameter. To analysis the need of face database which have age varying parameter, a new Indian Face Age Database (IFAD) is proposed. IFAD database contains Indian celebrities' images from childhood to old age. IFAD database not only shows age varying parameter but also shows variation in illumination, expression and pose but here in this research work the main concentration is only on varying age parameter. IFAD database is publically available and it can be used by researcher for their research work. More subjects can be added in future.

Table 1 shows the details of existing and proposed IFAD. From this table it is seen that most of the databases are not publically available. Only very few are easily available. Only a very few are available for age variation parameter. The proposed IFAD is publicly available (open source) database. It also has a large variation in age, pose, illumination and expression parameters.

Table 1. Details of Existing and Proposed Face Databases

S. No	Name of face database	Subjects	No. of images	Number of Parameters included in database	Availability of database as open source
1	FERET database	1199	14,126	Pose, illumination, age (variation is from 1993-1996)	Not
2	Multi PIE	337	more than 750,000	Pose, illumination variation	Not
3	Yale face database	15	165	facial expression	Not

4	ORL face database	400	40	Illumination variation, facial expressions.	Yes
5	JAFFE Database	60	213	Facial expressions	Yes
6	Indian Face Database	40	40x11	Pose and expression variation	Not
7	Indian Movie Face database	100	34512	Age, pose, gender, expression occlusion	Not
8	Labeled Wikipedia Faces (LWF)	1.5k	8.5k	Age, pose, gender, expression occlusion	Not
9	Proposed Indian Face Age database (IFAD)	55	3296	Age, illumination, pose, expression	Yes

3. AGE ESTIMATION FOR FACE RECOGNITION

A large amount of information regarding identity, gender, age, head orientation, emotions etc can be delivered by a single image of a person. It is important for face-to-face communication between two persons. Human has an ability to recognize and understand facial expressions in real world. But communication between machine and human is very difficult. As part of this effort many researchers have been working in the area of automatic interpretation of face images so that contact-less Human Computer Interaction (HCI) based on facial gestures can be developed. Age estimation can help in secure internet access control. Site access is controlled according to age group. Permission is not granted to access internet with unsuitable adult material to under-aged persons [10]. The support vector machine (SVM) and support vector regression (SVR) methods are investigated for age prediction based on the learned manifolds [11]. A system with large number of images which is a combination of MLBP, Gabor filtering and SVR gives better results of age estimation using gender and facial expression [12]. Age estimation is tag a face image automatically with the exact age (year) or the age group (year range) of the individual face. Fig.1 shows the age estimation modal.

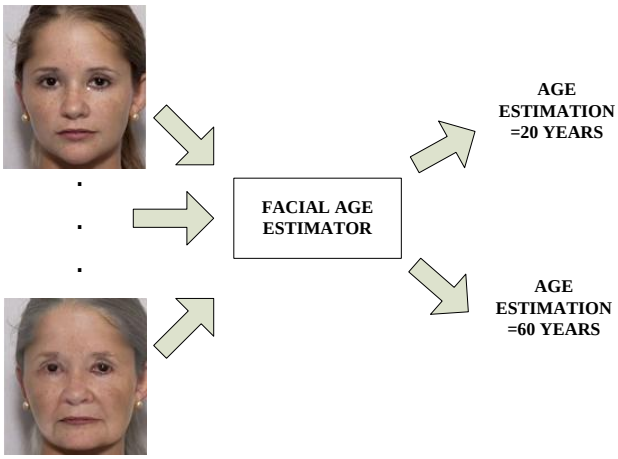

Fig. 1. Age estimation modal

Face recognition with age estimation is an important problem. Human face shows many variations with the passage of time. There are many factors such as facial features like eyes, nose, lips shape, skin color, facial texture like wrinkles, facial lines and presence of eye spectacles which play major role in age estimation. It has many applications secure internet access control, passport photo verification, image retrieval, surveillance, etc. There are several typical images with different age gaps. Figure shows images of a person at different ages. From the figure it is seen that face shape, skin texture (wrinkles), weight changes with age. Even though age estimation is important for face recognition but relatively less studied are shown on this, it is mainly due to the lack of suitable data sets. So here we are proposing a database Indian Face Age Database (IFAD) which can be used for face recognition using age estimation. Face recognition using age estimation can be useful in passport verification, internet access control for under age persons.

Fig. 2. Appearance of Human Face Changes Remarkably with Time

4. FACE DETECTION

Viola-Jones algorithm is used for face detection in the proposed Indian Face Age Database IFAD. It makes development of human machine communication. Image segmentation integrates the detected faces in complex backgrounds and locates face features such as eyes, nose, mouth, lips. Viola Jones (VJ) [13], [14], [15], works as follows:

Viola-Jones face detector uses features instead of pixels because features encode ad-hoc domain knowledge and faster than pixel based system. Haar functions are simple features. These are also called Haar features. Three types of features are used. These are two-rectangle feature, three-rectangle feature and four-rectangle feature. The fig.3 shows rectangular features.

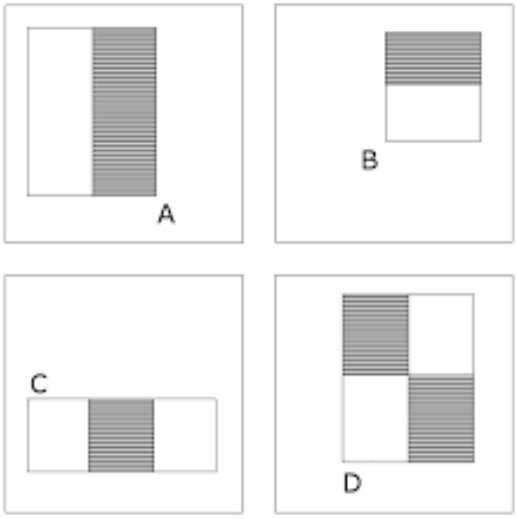

Fig. 3. Two-rectangle features are shown in A and B. C shows a three-rectangle feature. D shows four-rectangle feature

Integral Image is intermediate illustration for the image that is used to compute rectangle feature. The value of integral image is calculated by finding difference between the sums of the pixels within the two rectangular regions. The integral images at location p,q contains the sum of pixels above and to the left of p,q generally:

$$ii(p,q) = \sum_{p'\le p,q'\le q} i(p'q') \quad (1)$$

Where ii(p,q) is the integral image and i(p,q) the original image.

$$s(p,q) = s(p,q-1) + i(p,q) \quad (2)$$

$$ii(p,q) = ii(p-1,q) + s(p,q) \quad (3)$$

Where s(p,q) = cumulative row sum, s(p,-1)=0 and ii(-1,q)=0.

The fig.4 is integral image. In this figure at point (p,q) the value of integral image is the sum of all pixels above and to the left. The sum of pixel within rectangle S can be calculated with four array references. The value of the integral image at location 1 is the sum of pixel in rectangle P. the value at location 2 is P+Q, at location 3 is P+R and at location 4 is P+Q+R+S. the sum within D can be computed as (4+1)-(2+3).

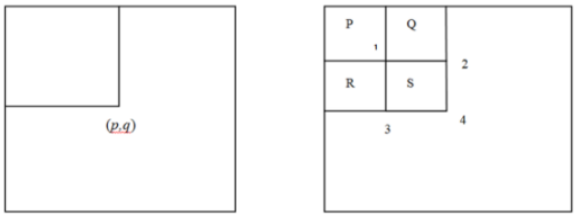

Fig. 4. The Integral image

AdaBoost is a machine learning algorithm used to select Haar features and threshold levels. Weak classifier is represented as:

$$h(x,f,p,\emptyset) = \begin{cases} 1 \text{ if } pf(x) > p\emptyset \\ 0 \quad \text{otherwise} \end{cases} \quad (4)$$

where x = 24x24 sub window, f = Haar feature, p = polarity and ∅= threshold that decides whether x is face or non face. If x is positive then it is face and if negative the non face.

Many weak classifiers are combined to make strong classifier. These are called cascade classifiers. Fig.5 shows the cascade classifier. As shown in fig.3 each stage find whether given sub-window is face or not. It discards the Non face but when if it finds face then it passes to next stage in series.

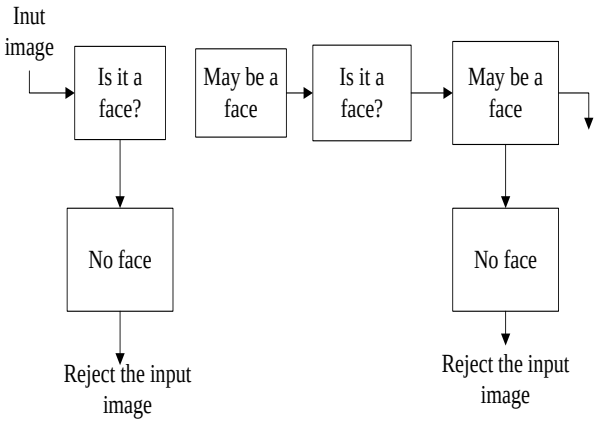

Fig. 5. Cascade classifier

Fig. 6 shows output of sample face detector image from proposed IFAD. The face and its parts are detected from the raw input image. Five parts of the input image are detected these are as follows:

1. Outer face part: It is represented by green box.
2. Eyes: It is represented by two pink boxes.
3. Nose: It is represented by yellow box.
4. Mouth: It is represented by sky blue box.

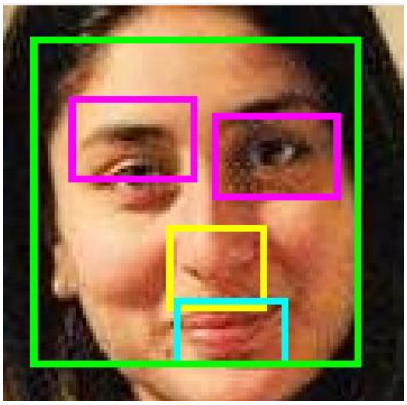

Fig.6. Output of face detector

5. ARCHITECTURE OF PROPOSED IFAD

The architecture of the proposed IFAD is according to the flow chart shown in the fig.7. Large number of images were collected from online sources. All the images are of Indian celebrities. That is why it is named as Indian Age Face Database (IFAD). For creating the database the raw images are collected. From these images face is detected by Viola Jones (VJ) Haar like cascade features for face detection.

The task of face selector is to select most prominent face from the set of images from the face detector. Each collected face is tagged with a age or identity. Age tag we will use in future for further improvement in the proposed IFAD. Face enhancement operations can be used for improvement

purpose. The IFAD script is in MATLAB and is prepared in such a way that any researcher can do face enhancement on it. After face enhancement IFAD is stored for face recognition or any other purpose.

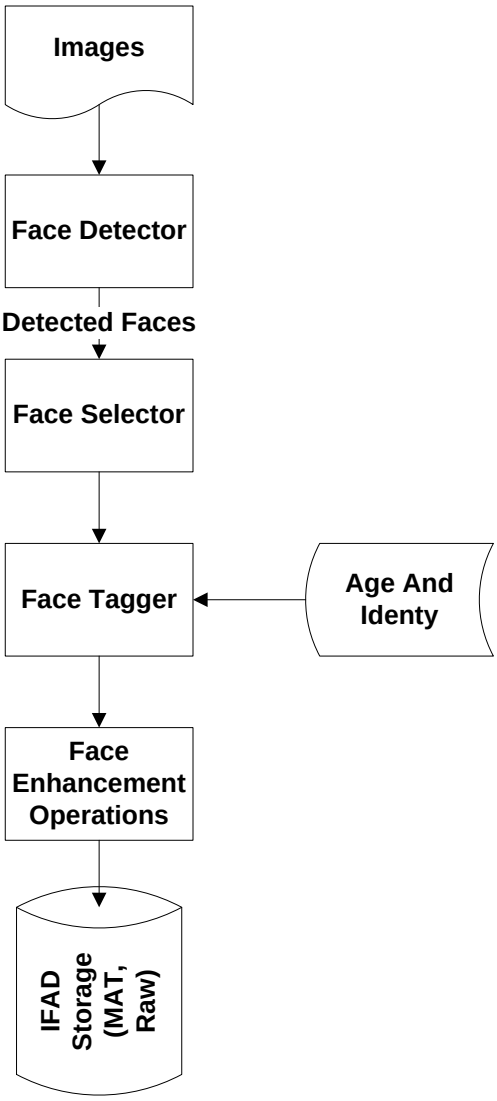

Fig. 7. Flow chart of proposed IFAD

6. HOW TO USE PROPOSED IFAD

In the proposed IFAD images can be used in 32X32, 64X64, 96X96 and 128X128 dimension size. The raw images were collected from online sources. The images in proposed IFAD were not preprocessed. It can be preprocessed by face enhancement techniques by researcher according to the requirement of their algorithm. The script of IFAD is in MATLAB. The script and dataset images are available on Github location http://github.com/IndianAgeDatabase/IFAD.

Anybody can use it and help to improve it. In IFAD there are 55 subjects and these 55 subjects have 3296 number of images. All images are placed in increasing order of age (from childhood to old age). The images are placed as shown in fig. 8. Person ID means subject name or any tag which is given to subject.

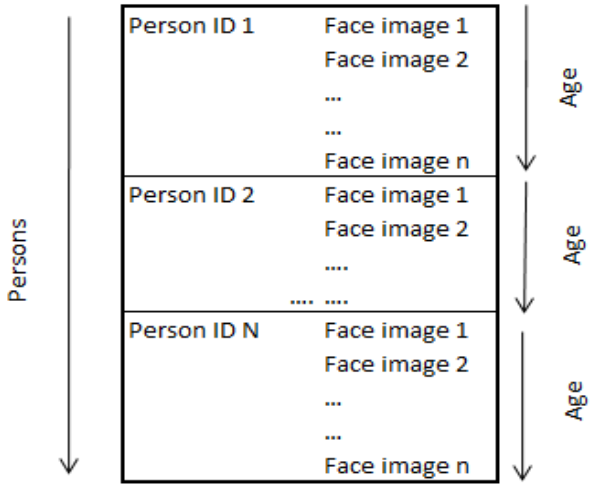

Fig. 8. Order of images in proposed IFAD database

7. GENERAL STATICS OF IFAD

There are 55 subjects (persons) in the proposed IFAD. Each subject has different number of images. There are in total 3296 images in the proposed IFAD. The proposed IFAD is available with 32x32, 64x64, 96x96 and 128x128 dimensions. According to their dimensions the file size and number of faces varies. This is explained in table II. The number of subjects will be fixed. Here number of subjects are 55 but number of faces varies according to size. As the dimensions changes the number of faces decreases and file size increases. The sample images from proposed IFAD are shown in fig.9. The mean face of subject1 is also shown in fig.10. In proposed 32x32 IFAD, the total number of images are 3294 out 3296 images, 2 were rejected by the algorithm The frequency of faces for each subject is shown in fig.11.In IFAD 32x32 1414 number of images are male images and 1882 are female images.

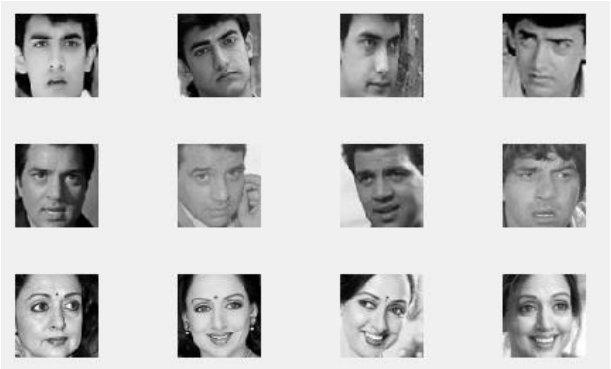

Fig. 9. Sample images of proposed IFAD

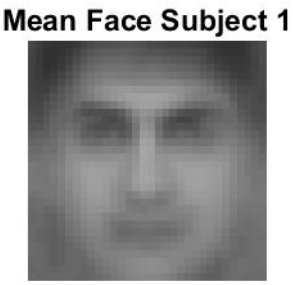

Fig. 10. Mean face of subject 1

Table 2. Different dimensions of proposed IFAD

S. no.	No. of subject	Dimensions	File Size	No. Faces	ID
1	55	32x32	24792 KB	3294	1x3294
2	55	64x64	86004 KB	2859	1x2859
3	55	96x96	133088KB	1968	1x1968
4	55	128x128	154181KB	1283	1x1283

Frequency analysis is useful for finding interesting patterns of any dataset, a good dataset should contain varying number of images of the subjects the database frequency distribution with respect to subject is shown in fig.11 below, it is clear that database does not contain fixed number of sample for the subjects rather a random mixture is observed. Random mixture is beneficial for testing any classification algorithm.

Mean face of complete IFAD is shown in fig.13. As there are more number of female subjects as compare to male subjects. This distinctive feature makes the overall mean image more feminine shown in fig.13. As it is seen from fig.12 that ratio of male and female is not same but female subjects are more.

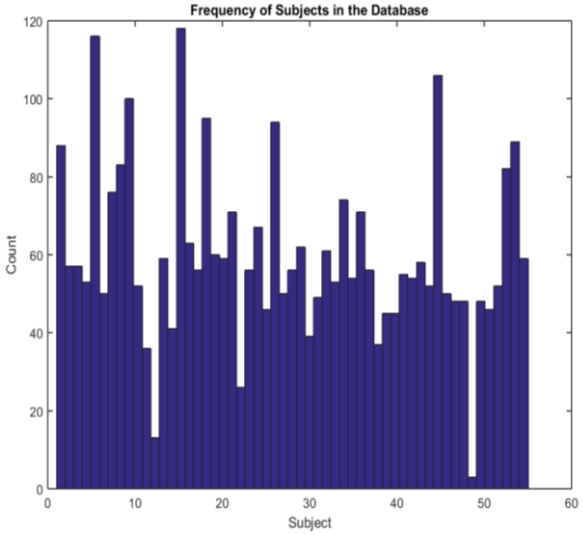

Fig. 11. Frequency of face of each subject in IFAD

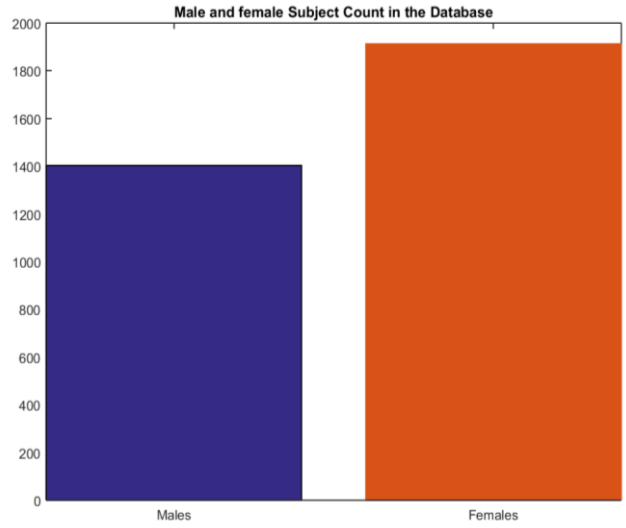

Fig.12. Male and female subject count in IFAD

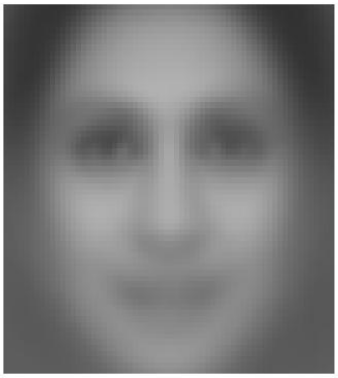

Fig. 13. Mean face of complete IFAD

8. CONCLUSION AND FUTURE SCOPE

The proposed Indian Face Age Database (IFAD) is very versatile face database. There are 55 subjects and total 3296 number of images. IFAD can be used for recognizing faces with varying age, pose, expression, illumination, and many more. In proposed IFAD 1379 number of images are male images and 1882 are female images making it the only the database with high gender variance.

In future age tags and face enhancement operations will be implemented for IFAD.

9. ACKNOWLEDGEMENTS

I would like to express my greatest gratitude to my guide Dr. M.S Patterh Department of ECE, Punjabi University for his continuous support for the paper from initial advice & contacts in the early stages of conceptual inception & through ongoing advice & encouragement to this day. I would like to thank the anonymous reviewers for their constructive comments

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