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An Expansive Study of Facial Approaches

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***Abstract*-** Biometrics is the study of human behavior and features using their biological patterns. Nowadays face recognition plays a leading role in biometric for identifying a person without human cooperation. It is most efficient and sophisticated security system. The face recognition system can be applied to a variety of applications, such as searching for a criminal record, searching for a particular crime, finding missing children based on a monitoring site and track crime detection in ATMs. There are two reliable biometric acknowledgment procedures, for example, unique mark and iris acknowledgment. In any case, these methods are meddling and their prosperity depends exceedingly on the client collaboration since the clients are requested to position their eye before the iris scanner or put their finger on the unique finger impression gadget keeping in mind the end goal to finish the procedure. This can be viewed as a convoluted procedure for a typical man. Then again, face recognition is non-meddlesome since it depends on pictures recorded by a removed camera and can be extremely compelling regardless of whether the client doesn't know about the presence of the face recognition framework. In this paper, a comprehensive investigation of face detection and face recognition strategies together with face databases are delivered.

***Keywords*-** *Face* detection, face recognition, face database, SVM, neural networks, SIFT

I. INTRODUCTION

The main applications of face approaches are verification/detection and identification/recognition. At the start, the face detection is done on the input image. The relevant features are extracted with the help of certain techniques from the input image and then the recognition techniques are applied. Finally, the output recognition is performed and the result is produced.

Figure.1 Process of Face Recognition

The above figure 1 shows the steps involved in face recognition process: The first step is face detection, the second is feature extraction, and the final step is face recognition. These steps depend on each other for the processing and often use similar techniques.

1.1 Approaches to Face Recognition:

Face Detection: Face detection is a technology, being utilized in a diffusion of programs that identifies human faces in virtual images that are captured from still photographs to real-time cameras.

Feature Extraction: Feature extraction is a technique that is a preliminary for making the classifications. The face images are taken and the information is derived from the images that are supposed to be informative and non-redundant in some instances leading to higher human interpretations. Feature extraction is related to Dimensionality discount.

Face Recognition: Face recognition is a function that capable of identifying or verifying a person from virtual images [1].

1.2 Face Recognition Issues:

Although the face recognition is a platform to the enable the people to build Human-Computer Interaction systems, there are some major drawbacks to it. The major drawbacks with face recognition are as follows,

Illumination Problem: Same faces appear differently due to the change in lighting.

Pose Problem: Face recognition with different facial poses is known as pose problem. If a person tries to match the same

image with the different facial pose, it shows a different result [2].

The other problems of the face recognition system are facial expression change, aging, scaling factor (i.e. size of the image) frontal Vs side view, presence, and absence of spectacles, beard, mustache, occlusion due to scarf, mask or obstacles in front [3].

Section II describes the literature study; the section III describes the review of face detection methods and faces recognition techniques and databases; section IV concludes all the research directions.

II. LITERATURE STUDY

This section discusses various research works related to face detection, face recognition, and face databases.

2.1 FACE DETECTION METHODS

Face Detection methods are divided into 4 categories as detailed below:

2.1.1 Knowledge-based methods:

The knowledge-based methods are based on the geometry of the facial features. These are rule-based methods. They try to capture our information of faces and translate them into a set of rules. A rough estimate of face geometry is used for person recognition at higher levels [4]. The natural balances of the face are describing the rules for shape, size, and texture and other facial features characteristics like eyes, nose, chin, relative position and distance between them. For example, a face usually has two symmetric eyes, and the eye area is darker than the cheeks. Facial functions might be the distance between eyes, color intensity and the difference between the eye vicinity and the lower region. The large troubles in these techniques are difficulty in constructing an appropriate set of guidelines. There can be many false positives if the regulations had been too standard. Then again, there may be many false negatives if the regulations have been too specified [5].

2.1.2 Feature-invariant methods:

Feature-invariant methods find invariant features of face angle or position. Facial recognition features such as mouth, nostrils, eyes, cheeks, chin, lips, forehead, ears, mouth edges, nose area, and jaw access. [6] These approaches target to find the faces with facilitate of structural options that square measure gift even within the variations in light-weight or distinct viewpoint. Then, the existence of face is verified with facilitate of applied mathematics models, thresholding, and edge detectors. The people have completely different color. Some techniques have tested that color is taken into account to be one in all the most effective options for face detection.

2.1.3 Template- matching methods:

Template- matching methods try and notice a regular template of all the faces. In these ways, completely different options will be outlined severally [7]. Face templates will be determined and support the chance of the external body part inside the given image. For example, a face will be divided into eyes, face contour, nostril, and mouth, likewise as face model is also designed by suggests that of edges. But these techniques are restricted inside the faces that are frontal. Therefore, the completely different templates use the relation between face regions as well as brightness and darkness. This approach is simple to enforce, but it's inadequate for face detection. It cannot acquire actual effects with the versions of pose, scale, and form [8].

2.1.4 Appearance-based methods:

Appearance-based methods are typically used for facial function extraction and reputation. In the functions have been applied skin colors, the shape of lips, distinctive mouth positions open and closed [9]. The diverse face detection strategies are based on Appearance-based methods. It includes are PCA, Haar-like features, LDA, and SVM. It can be used to discover the probability of distribution and pixel brightness of images. Face reputation involves diverse strategies which might be used as according to the user's requirement [10].

2.2 FACE RECOGNITION TECHNIQUES

In this section, the various face recognition techniques are explained along with their references.

2.2.1. Haar-like features:

The grayscale image is collected which can be black, gray, and white. Black and gray are subtracted from the white. Finally, the result is the only grayscale, according to the strategy. It might be as it is compared with the defined threshold [11].

2.2.2. Separate Haar:

There may be a possibility of various locations and edge angles. This is in between the adjoining rectangles of Haar capabilities of exceptional training face samples. Facial features are inadequate to differentiate the poor samples. Because of this, it is not possible to connect the adjacent rectangles with one another. It is referred as Separate Haar characteristic and gets an enormous price for every characteristic [11].

2.2.3. Color-based model:

In this model, skin features such as pores and skin region can be detected by color models like RGB and others. Making use of skin shade data, the color image is transformed to its grayscale equivalent, and then the binary image is obtained with the help of appropriate threshold. After getting the binary image, the noise is eliminated. Finally, the facial features are extracted from the binary image with the help of threshold for awesome quantities [12].

2.2.4. Principal Component Analysis (PCA):

PCA is a technique for character selection and measurement reduction. This is a famous technique in the discipline of face detection. PCA became first used for human face recognition. It mainly used for reconstruction of human faces. This feature is described in the scale of initial information area is decreased and the new area obtained [13].

2.2.5. Gabor wavelet:

Face Recognition is one of the maximum essential packages of Gabor wavelets. In this package, the input image is convolved with the set of Gabor wavelets and the output images are similarly processed. In latest years, a number of researchers on face recognition had been carried out and roughly tactics are proposed [14].

2.2.6. Linear Discriminate Analysis (LDA):

LDA provides an efficient way to linearly transform the preliminary information space of the low dimensional area of capabilities. The records are characterized by LDA by means of the linear mixtures and differentiate the features of the face [15].

2.2.7. Independent Component Analysis (ICA):

This method seems for additives that are non-Gaussian and statistically independent. In ICA, each face image is transformed into a vector and unbiased additives are calculated. That ICA structure yields highest overall performance for figuring out faces [16].

2.2.8. Neural Networks:

A neural network is based on the multi-layer feed ahead algorithm. It is applicable to pattern matching due to its simplicity. MLP (Multilayer Perceptron) is a community in which there is a strong and fast source node. The neural network is designed with one input layer, one or more hidden layers and one output layer for pattern matching [17].

2.2.9. Support Vector Machine (SVM):

An SVM classifier is trained for each person in the database. SVMs are known as maximum margin classifiers. When it comes to classification problems, SVM provides a way for face recognition [18].

2.2.10. Scale Invariant Feature Transform (SIFT)

SIFT is used to detect and describe the local features in images. It is tolerating the 128-dimensional vector which can be utilized to recognize the system cycle as a pixel. The SIFT separates the key focuses (spots and descriptors) for the entire database. For instance, the given modified image, SIFT extricates the key point for image and analyzes that point to the dataset [19].

2.2.11. Speed up Robust Features (SURF)

This technique fits the key point factors among adjusted images and each database. SURF descriptor is invariant to scale and revolution capacities. It incorporates interest factor identifier and diversion point descriptor. SURF, for the most part, utilizes 64 measurements to lessen the ideal opportunity for coordinating and calculation capacities [20].

2.3. FACE DATABASES

Several face databases are available for face recognition researchers. All these databases consist of facial datasets of varying size and scope. This section describes some of them.

2.3.1 AT&T (ORL) Database:

The AT&T database, conjointly called ORL database incorporates 40 completely different kinds of persons with 10 images for every one of them and it is associated by overall 400 images. This dataset contains 4 female and 36 men samples. Each image is of size 92x112 pixels, a total of 10,304 pixels, and therefore the documents area unit in PGM layout. The information is employed in the face recognition challenge [21].

2.3.2 FERET Database:

The FERET database could be a renowned dataset used for face-name structures. The FERET application is managed by the defense advanced analysis initiatives corporation (DARPA) and therefore the national Institute of needs and generation. This faces figurative process information was accumulated between Dec 1993 and August 1996. The images are separated into sets of the gallery and investigate snapshots. Gallery copy is acknowledged labels, whereas investigate copy are matched with gallery images for identity [22].

2.3.3 AR Face Database:

This database is used for facial expression quality. The AR info incorporates over 4000 frontal images of 126 subjects (70 males and 46 females). Everybody has 26 samples captured in separate categories on specific days. It includes 13,576x768 pixels image in step with session [23].

2.3.4 CMU-PIE Database:

Carnegie Mellon University (CMU) has collected characteristics of face information (PIE) images. The PIE information has already created a major impact on formula development for face recognition process and on the analysis of face recognition algorithms. This information consistently considers various poses and illumination conditions at the side of varied facial expressions. This information has been distributed to over 150 analysis teams [24].

2.3.5 Yale Face Database B:

The Yale face database B is collected to check the face recognition lighting variations. The images of the person area unit captured with 64 computer-controlled substance element strobes. The images of 10 person area unit recorded in 9 poses (5 poses at 12°, 3 poses at 24°, and one frontal read from the camera axis) underneath 64 completely different lighting conditions [24].

2.3.6 UMIST Face Database:

UMIST database is made by the University of Manchester Institute of Science and Technology. The UMIST info consists of images with variable poses. This info is primarily used for face recognition. A complete 20 persons are enclosed during this info, with a complete 564 8-bit grey and 92x112 images. The image poses area unit captured from the side view and frontal views [25].

2.3.7 MUCT Face Database:

The database from the Milborrow/University of Cape Town (MUCT) consists of 3,755 faces with 76 manual landmarks. The database is formed by diversifying lighting, age, and quality. During this info, all the images captured from the individual pose from university students, parents, high school academics, and staff. The image format is RGB, with a resolution of 480x640 pixels. Images captured exploitation webcams with Sony ICX098BQ CCD sensors. The camera is directly ahead of the person's face, which is directed up to some height variations of seated persons [26].

2.3.8 Face94 Database:

This database is a piece of an accumulation of face images. The accumulation contains four envelopes of images, specifically, face94, face95, face96, and scowl. The images are put away in 24-bit RGB and JPEG positions, and the camera utilized is an S-VHS camcorder. Face 94 contains 153 images, each with a determination of 180x200 pixels, and the catalogs include images of male and female people in isolated registries (20 females, 113 guys, 20 male staffs). The lighting is fake and a portion of the images are caught with glasses and a blend of tungsten and fluorescent overhead [27].

2.3.9 Indian Database:

The Indian database contains 40 unique people, every one 11 distinct postures. The documents are in 24-bit RGB and JPEG scene groups. The span of each image is 640x480 pixels. The images are sorted out into two principle indexes (guys and females). Every one of the images has a brilliant homogeneous foundation, and the people are in an upright and frontal position. The postures shift with the face looking forthright, looking left, looking right, looking into, gazing upward toward the left, turning upward toward the right, and looking down with different feelings [28].

2.3.10 Grimace Database:

The Grimace database contains human face images with 20 people. Each having 20 images with a little head scale variety. This database contains images of the 20 guys and females. The images are getting 24-bit RGB, JPEG design, and the span of each image is 180x200 pixel representation. The camera utilized is an S-VHS camcorder. [29].

III. REVIEW OF FACE DETECTION METHOS AND FACE RECOGNITION TECHNIQUES AND DATABASES

This section describes some of the facial approaches that are shown in below given tables namely Table 1, Table 2, Table 3 respectively.

Table 1. Face Detection Methods

Methods	Overview	Merits	Demerits
Knowledge-based methods	Capture our knowledge of faces, and translate them into a set of rules.	Easy to implement.	Difficulty in building an appropriate set of rules.
Feature-invariant methods	Distinctive features of the face like Mouth, Nose, Eye, Cheekbones, Chin, Lips, Forehead, and Ears are identified.	Find invariant features of a face irrespective of its angle or position.	Difficult to find Facial expression.

Template-matching methods		Different features can be defined independently for example; a face can be divided into eyes, face contour, nose, and mouth. Also, a face model can be built by edges.	Simple to implement.	Though this approach is simple to implement, it's insufficient for face detection. Limited to faces that are frontal.
Appearance -based methods	**Eigenface Based Methods**	Based on Principal Component Analysis (PCA reduces the dimension of the data) Create an image subspace which best discriminates between faces. It compares two faces by projecting the images with speed and measuring the distance between them.	Relatively simple, Fast, Robust. Works well in high dimension.	Complex to find the different head pose, different alignment, and different facial expression.
	Distribution based methods	Based on Fisher's Linear Discriminative Analysis Fisher's faces use the within-class information to maximize class separation.	Faster than Eigenfaces in some cases. Has a lower error rate. Works well even with different illumination. Works well even with different facial expression.	Small databases. Cannot work well in high dimension.

The above Table 1 describes the various face detection methods, the overview of the respective authors' research work along with its merits and demerits identified.

Table 2: Face Recognition Techniques

Techniques	Merits	Demerits
Haar-like features	Good detection rate.	Contribute a lot of false detection. Feature value is not powerful. Enough to separate from the negative samples.
PCA	Data compression is achieved by the low dimensional subspace representation. No knowledge of geometry and reflectance of faces are required.	Very sensitive to scale, therefore, a low-level preprocessing is still necessary for scale normalization.
LDA	Optimizes the low dimensional representation of the objects with a focus on the most discriminate feature extraction.	It fails when all scatter matrices are singular A critical issue using LDA is the Small Sample Size (SSS) Problem.
Neural Networks	Requiring less formal statistical training. Ability to implicitly detect complex nonlinear relationships between dependent and independent variables.	Greater computational burden. Proneness to overfitting. Execution time is more.
SVM	SVM classifiers can achieve better generalization performance.	Cannot be applied when feature vectors defining samples have missing entries.
ICA	ICA architecture yields the highest performance for identifying faces.	This method looks for components that are non-Gaussian and statistically independent.
SIFT	SIFT descriptor is accepting the 128- dimensional vector which used to identify the neighborhood around a pixel.	It is mathematically complicated and computationally heavy.
SURF	Convolution with box filter is not required, so no need of finding orientation, which speeds up the process.	SURF usually uses 64 dimension vector to reduce the time cost for both feature matching and computation.

The above Table 2 describes the various face recognition techniques and its respective merits and demerits described in the research work. <<Give the best feature selection method for readers >>

Table 3. Face Databases Features.

Name	No of faces	Image Resolution
AT&T (ORL)	40	92 x 112 Gray Scale
FERET	1199	256 x 384 Gray Scale/ RGB
AR Face Database	126	576 x 768 RGB
PIE Database, CMU	68	640 x 486 RGB
BioID Face Database	23	382 x 288 Gray Scale
The Yale Face Database	15	320 x 243 Gray Scale
The Yale Face Database B	10	640 x 480 Gray Scale
UMIST Face Database	20	92 x 112 Gray Scale
The MUCT Landmarked	276	480 x 640 RGB
Face 94	153	180 x 200 RGB
Indian Database	40	640 x 480 RGB
Grimace Database	20	180 x 200 RGB

The above table 3 describes some of the available face databases, the number of faces and the resolutions in them.

IV. CONCLUSION

In this study, we have discussed the various face recognition techniques, face detection methods, and databases. It is also clear that many researchers are consequently doing their research in various face recognition approaches. Face recognition accuracy depends on the quality of an illustration from the image. There are many applications of this technology and we have discovered some recommendations to researchers, such as applying real-time face videos and video frames when working with the above-described techniques. In this survey, the discussion is mainly concentrated on the various Face detection and recognition techniques. This study can be expanded further by analyzing and adding various other techniques involved in face detection, recognition, and databases. The lists of references are provided to give more details for understanding the approaches described in this study.

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