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A Survey on Facial Recognition

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Abstract – Face recognition is one of the most interesting and challenging research area in the past decades. The face recognition system has used facial databases which can verify whether the given facial image is found in the database or not. It is very popular in biometric authentications and surveillance and they do not require the user intervention. Face recognition technique is definitely an emerging multi-disciplinary subject that facilitates discovering of previous unknown patterns from large amount of data. This paper provides the basic concepts of Facial Recognition and its essential characteristics. Face recognition in IoT, biometric system, crowd detection are also discussed in this paper.

Keywords - Face Detection, Face Recognition, Biometrics, IoT based face recognition, Applications.

I. INTRODUCTION

Face recognition is an attractive research, in the field of computer vision and image processing; it deals with verifying or identifying a face from constrained and unconstrained input images [2] [4]. Face recognition system has used facial databases which distinctively identifies or verifies a person. Face recognition system is used in various real world applications, especially used for security purposes. Faces are real projector panels of the mechanism, which govern emotional and social behavior. The number of possible facial expressions is unlimited, since face has 44 muscles and more than 250,000 facial expressions. [1]. Facial image database contains both constrained and unconstrained sets. In constrained set, faces are very easy to recognize, because of its frontal view and it also allows different facial poses. On the other hand unconstrained set contains partial portion of faces and non-frontal facial images.

A face recognition systems are performed based on the different nodal points of a human face. The robustness of this system can be obstructed by humans who alter their facial features through wearing colored contact lenses, growing a mustache, putting on intense make-up, etc. There are numerous face recognition techniques are available for recognize the facial features from large amount of data set.In unconstrained sets, the unreliable conditions which includes are changing pose, expressions, occlusions, varied lighting and non-frontal, illumination and low-resolution [5] [11] [12]. This imperfection of image affects the results of the face recognition system and it has become a challenging research problem. Hence face recognition system needs to translate unconstrained (non-frontal) sets into constrained sets [3]. A proper reduction of pose variation is essentially advantageous for feature extraction and facial attribute analysis [6]. There are different types of face recognition techniques are available for detecting the facial features from large amount of facial data set. Most of the face recognition systems performances are based on the different nodal points on a human face. The values measured against the variable associated with points of a person's face helps to uniquely identify or verify the person.

The prime aim of this survey paper provides the basic concepts of Facial Recognition and its essential characteristics. Face recognition in IoT, biometric system, crowd detection are also discussed in this paper.

The remaining portion of the paper is organized as follows. Section II presents the related works of the face recognition system. Section III provides the face recognition system architectures. Section IV represents IoT based Face Recognition System. Section V gives Applications of Facial Recognition. Research issues are discussed in Section VI. Section VII gives the conclusion.

II. RELATED WORKS

Jawad Nagi, et.al [9] proposed an image-based approach towards artificial intelligence by removing redundant data from facial images through image compression using the two-dimensional discrete cosine transform (2D-DCT). The DCT extracted features from face images are based on skin color. Feature vectors are constructed by computing DCT coefficients. A self-organizing map (SOM) is an unsupervised learning technique which is used to classify

DCT-based feature vectors into groups to identify if the subject in the input image is "present" or "not present" in the image database. Face recognition with SOM is carried out by classifying intensity values of grayscale pixels into different groups.

Kirby, et.al [19] proposed principal component analysis technique to efficiently represent pictures of faces. They argued that any face images could be approximately reconstructed by a small collection of weights for each face and a standard face picture known as Eigen picture. The weights describing each faces are obtained by projecting the face image onto the Eigen picture.

Tjahyadi, et.al [20] proposed a DCT method for energy histogram-based facial classification using 8 × 8 blocks and then calculates energy histograms over the yielded coefficients. They form several different feature vectors based on histograms and then it calculated Euclidean distance which is necessary to classify the facial images. They tested their system on a small facial database and get an average recognition rate increase of 10 % compared to standard PCA method.

Chen, et.al [21] analyzed face recognition system, using ortho normal transformation i.e. DCT of original data which does not change the projection in PCA and LDA subspace. Then it divides the facial image in 8 × 8 blocks and performs standard DCT and quantization on each block. Feature vectors are formed by rearranging all the coefficients in a zigzag manner.

Delac, et.al, [23] proposed face recognition in compressed JPEG2000 domain. Standard JPEG2000 scheme has been used and stopped the decompression process at point B (right before the inverse DWT). Tested by three well-known face recognition methods (PCA, LDA and ICA) with three different metrics, yielding nine different method-metric combinations. FERET database is used along with the standard accompanying protocol. No significant performance drops were observed in all the experiments.

Yang, et.al [24] proposed the face recognition technique for identified the requirements for secure information systems, multimedia systems and cognitive sciences. Such solution called D-LDA to solve the small sample size problem. Unlike conventional LDA, D-LDA starts by diagonalizing the between-class scatter matrix.

Silva, et.al [26] proposed Eigen-eyes to handle several challenges of face recognition including disguise using the Yale database. Advantage of this algorithm is that alterations in the facial features excluding the eye region which do not affect the accuracy. This algorithm is able to achieve an accuracy of around 87.5%.

Pamudurthy, et.al [27] proposed a face recognition algorithm which used dynamic features obtained from skin correlation and these features are matched using nearest neighbor classifier. This result suggested that the high degree of disguise variation is more challenging to address compared to variation in pose, expression and illumination.

Alexander, et.al [28] used PCA based algorithm with Mahalanob is angle as the distance metric. The result shows an accuracy of 45.8% in the AR database. The limitation of these algorithms is the performance degrades when important regions such as the eye and mouth are covered. Moreover, the AR and Yale databases do not contain many images with disguise and therefore are not ideal for validating algorithms under comprehensive disguise scenario.

Kim, et.al [11] proposed a Kernel PCA based face feature extraction method. This method has used polynomial kernel principal components to compute the product space of input pixels to generate a facial pattern. The effectiveness of their proposed method, an SVM method used as the recognition with ORL database.

Gan, et.al [12] proposed the normalization method within class average face image and analyzed the advantages of PCA. They compared with traditional PCA method, and their result becomes more acceptable with different class and same class. This showed the higher correct recognition rate and then a better efficiency can be achieved.

Timotius, et.al [13] proposed the KPCA method, to extract features from the input images and SVM method is applied to classify the input images. They compared the performance of the face recognition method to other commonly used method. It achieves a higher performance as compared with SVM, and the combination of kernel principal component analysis (K-PCA).

El Traboulsi, et.al [14] analyzed the semi supervised discriminant embedding which is the semi-supervised extension of Local Discriminant Embedding (LDE). This type of methods is in general dealing with high dimensional data. The classic solution to this issue is to reduce the size of dimension of the original data; the reduced number of features is less than the number of samples. This can be achieved by applying Principle Component Analysis (PCA).

Vieira, et.al [15] proposed the methodology for contributing in the automation of mapping over big areas. They have combined two major methods, which includes object based image analysis. It is used to represent the knowledge, which requires the mapping method and generate the knowledge model. This showed the higher correct recognition rate and then a better efficiency can be achieved.

III. METHODOLOGY

Face recognition is uniquely identifying or verifying a person and this system uses a facial database of images and compares another image against those to find a match, if one exists. Face recognition system has used the following approaches to detect faces from a facial image database. They are Pre-processing, Segmentation, Feature Extraction, Face Detection and Recognition.

1. Preprocessing

To improve the performance of the raw facial image it need to undergo some pre-processing stage. The preprocessing is very essential for face recognition system and face detection system.

1.1 Noise Removal

Noise removal is one of the pre-processing stages of image processing. There are different types of noises, which corrupts the facial images. These noises are appeared on images in different ways such as at the time of acquisition due to noisy sensors, due to faulty scanner or due to faulty digital camera, due to transmission channel errors, due to corrupted storage media. Noise hides the important information from images. Hence it is essential to remove noises from the images without any loss of image information. Different filtering techniques such as Median, Average, Gaussian and Weiner Filters are available for removing the noise from raw face images [33]. Figure 1 shows Sample noisy image.

1.2 Illumination

Illumination is one of the challenging problems in face recognition system. Different lighting atmospheric condition such as shadows, underexposure and overexposure in the face image makes difficult to track the particle face image. Due to this lighting variation, face appearance may be changed. Different methods like Histogram equalization (HE), Logarithmic transform, Gray-level transformation, Gradient or edge extraction are used to overcome this illumination process. Figure 2 gives sampleIllumination and blurred image.

Figure 1 Noisy image

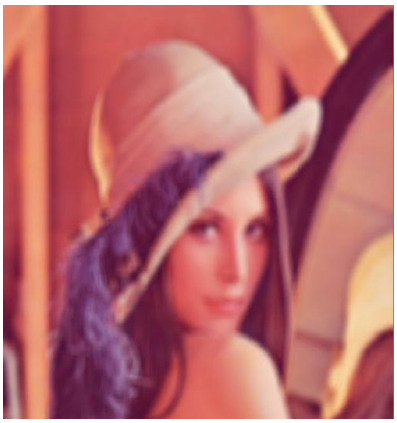

Figure 2 Blurredimage

Figure 3 Low Resolution image

1.3 Low resolution

In video surveillance application the resolution of outdoor video may be affected by unrestrained illumination. The low resolution face image contains less information compared to other high resolution images. To overcome this problem super resolution algorithm is used. Super resolution algorithm produce an image with high resolution from many low resolution images of the same scene, using signal processing techniques. Sample Low Resolution image isrepresented in Figure 3.

It consists of three stages.

1. *Registration*, it is the estimation of motion information between the low resolution images and the reference of high resolution image.
2. *Interpolation* onto high resolution grid, since the shifts between LR images are all different from each other, the generated HR image will not always match into a uniformly spaced HR grid. Therefore interpolation is needed.
3. *Removing blur and Noise*.

Edge detection

Edge detection is the process of identifying and locating an edge of a digital image and it is used in most of the image processing applications to obtain information from the

frames [17]. It is an important terminology in image processing and computer vision with wide range of applications [18]. Edge detection plays an important role in face recognition system and it is the process of finding and locating sharp discontinuation of pixels in the facial images. Figure 4 shows the Edge Detected in facial image.

Figure 4 Edge Detected image

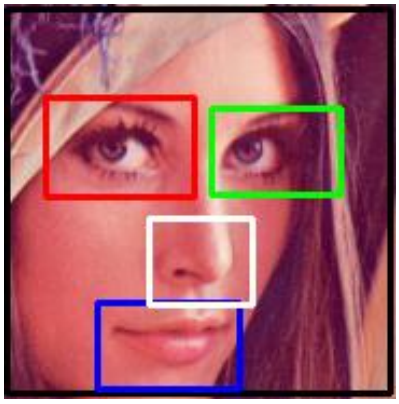

Figure 5 Feature Extraction image

Feature Extraction

Facial images have many features like color, texture and shape exists to track the faces. Each feature is unique to the object and remains unchanged even if the object moves. Figure 5 gives Feature Extraction of facial image.

Color feature is one of the most commonly used features in face recognition. The color of a face image is represented by using color models to describe color information.

Texture is another important feature in face recognition, which is described in various terms such as smooth, uniform, flat, coarse, grainy, even, uneven and random.

Shape based feature extraction is used to extract facial features like eyes, nose, mouth and so on. It is used to determine the edges of the faces that have been detected as image contour.

Face Detection

The next stage in succession is face detection module which is called only if motion is detected. Face detection algorithm is applied only to the region which is segmented from background subtraction stage and identified as moving object. Tracking the face includes, using the selected skin tone features, the histogram based tracker use to provide the capability to track an object using histogram of pixel values. To detect the location of a face in the video frame, vision cascade object detector is used.Figure 6 shows feature detected image.

Figure 6 Feature detected image

Face Recognition

Template matching is the most important face recognition method for face verification due to its conceptual simplicity. It is useful for searching the facial image or its features from large facial image database. It is performed based on finding the regions of high correlation using eyes, nose and lips templates. Template matching is also a useful approach for face verification and it can be performed using an edginess-based representation of the face image [34]. Figure 7 presents face recognition image.

Figure 7 Face recognition image

IV. IOT BASED FACE RECOGNITION SYSTEM

IoT is an innovative technology, which has made an enormous impact on the modern world. IoT can be defined

as, the system interconnected with mechanical, electrical, computing devices and other objects like animals and humans [29].This technology integrates the objects which can be remotely controlled through sensors via internet which reduces the human interventions. IoT is primarily used for biometric applications for authentications, because the traditional security systems can't tackle some situations like hacking, break down in the system. Primarily, biometric features are used to unlock devices like smart phones and tablets to get to their home screen. Fingerprint, iris, facial recognition and voice recognition are using IoT system for authentication. Nowadays live face recognition system are used for security and automatic door opening in various organizations using sensors. IoT will enable sensing, actuating and communication in the automated system easily. Figure 8 represents IoT based face recognition system.

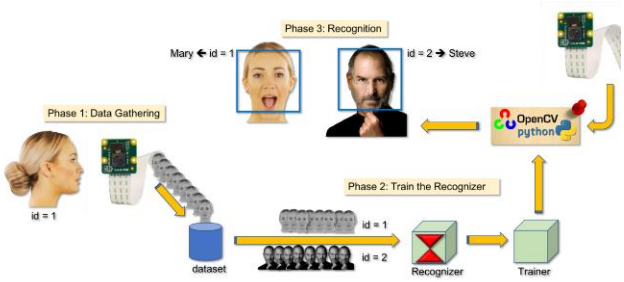

Figure 8.IoT based Face Recognition System

V. APPLICATIONS OF FACIAL RECOGNITION

Face recognition is used in various real world applications, they are listed as follows:

Biometrics is a growing technology, which recognizes a person by using different biological features like fingerprint, retina-scan, iris scan, hand geometry and face recognition[30].It is widely used in forensics, secure electronic banking, government IDs, security infrastructures, confidential financial transactions, retail sales, law enforcement, prison security, personal data privacy, social services and health care. Face Recognition is one of the important research and challenging problem in biometric recognition and authentication system. One of the most challenging phenomenon's associated with facial recognition is the accuracy for the real time images [31]. Biometrics face recognition is used to measure and analyze a person's physiological or behavioral characteristics. Face recognition system belongs to physiological biometrics. This is based on direct measurements of a part of the human body. The face recognition based biometric system first enrolls the unique and permanent facial fine points of a person and records them in the database. Once the enrollment process is complete, then just need to look at the camera to verify and identify the faces using face recognition techniques. Figure 9 shows biometric face recognition.

Figure 9 Biometric face recognition system

Figure 10 Face recognition from Crowd

Crowd detection and density estimation from crowded images have a wide range of application such as crime detection, congestion, public safety, crowd abnormalities, visual surveillance and urban planning. The purpose of crowd density analysis is to calculate the crowd counting, tracking individuals and finding the region of motion [32].Figure 10 shows the face recognition from Crowd. There are various approaches have been taken to handle the problem in crowd detection, which can be broadly divided into three types. They are

i) Detection based approaches - Detection model tries to determine the number of people by identifying a single person and their places at the same time. Detection based approach will be successful in the low-density crowd and affected in the high-density crowd.
ii) Regression based approaches - This approach handled a local image patches which extract mapping between features for counting purpose.
iii) Density based approaches - Density based approach tries to learn the linear mapping between local path features and corresponding object density maps.

Other application areas of face recognition system, listed as follows.

- Identity verification for national IDs, e-banking, electronic commerce, identifying newborns, passports, employee IDs.

- Image database investigations such as searching image databases of licensed drivers benefit recipients, missing children and police bookings.
- Security is a primary concern at airports and for airline staff office, immigration. Airport protection systems that use face recognition technology have been implemented at many airports around the world [10].
- Face detection is assisted to recognize the face from photo slideshows and burns effect. Face detection is gaining the interest of marketers.
- A webcam can be integrated into a television and detect the faces, this system calculates the age range of the face and gender.

VI. ISSUES IN FACE RECOGNITION

Illumination

Same face appears differently due to the change in lighting, more specifically the changes induced by illumination based on classifying the identity of input images. This has been experimentally observed with a dataset of 25 individuals.

Pose

Same face appears differently due to pose changes in viewing condition. Moreover, when illumination variation also appears in the face image, the task of face recognition becomes even more difficult.

Background

A facial recognition system may not produce the same results as outdoors compared with indoors because of the factors like impacting its performance, change as soon as the locations change. Additional factors such as individual expressions, aging etc. contribute significantly to these variations.

Occlusion

It is based on the face such as beard, moustache, accessories (goggles, caps, mask etc.) also meddle with the evaluation of a face recognition system. Such components make the subject diverse and hence it becomes difficult for the system to operate in a non-simulated environment.

Expressions

Significant factor needs to be taken into account is different expressions of the same individual. Macro and micro expressions find their place on someone faces due to changes in one's emotional state and in the wake of such expressions - which are many - the efficient recognition becomes difficult.

Face Frontalization

Face frontalization is used to identify the frontal facing view of face and it is a challenging task in face recognition system. Frontalization may substantially improve the performance of the face recognition systems

Crowd detection

The job of detecting a face in the crowd is complicated due to its variability present in human faces including color, pose, expression, position, orientation and illumination. There are many challenges addressed in crowd analysis such as occlusions, high clutter, contrast variations, non-uniform distribution of people, non-uniform illumination, low resolution, intra-scene and inter-scene variations [32].

VII CONCLUSION

Face recognition is one of the most important and challenging research domains in the field of computer vision and image processing. It is widely used for security and biometric purposes, though there is increasing interest in other areas of use. This paper has reviewed basics concepts of face recognition system and its applications. Different approaches in face recognition system and issues in face recognition system are also discussed in this paper.

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