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A Review on Identity Management Using Face Detection Techniques

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ABSTRACT

Face recognition, which has applications in iris and fingerprint recognition in addition to face recognition itself, is a crucial component of computer vision and object recognition.
In everyday life, face detection is critical in security and forensic investigations. Face identification, whether in fixed photos or video sequences, poses considerable hurdles due to elements such as facial expressions, position fluctuations, occlusion, aging, and resolution. The authors propose the notion of face synthesis to overcome these issues and improve accuracy. They want to enhance recognition rates when working with different face databases by using face synthesis techniques. The study provides an in-depth examination of various facial recognition algorithms, highlighting the problems involved and emphasizing the need to improve efficiency and recognition rates. for large face databases. To show the efficacy of the suggested strategies, the authors compare rates of accuracy and recognition.

Key words :PCA, LBP, Kernel, Convolutional layers, Precision.

1. INTRODUCTION

Face recognition is used in computer vision and image retrieval for autonomous control and communication; this area of research is constantly intriguing and has attracted a lot of interest.
Face detection, a branch of object detection, is one of the fields based on computer-human interaction. Face detection is the first step in all facial analysis techniques, including face recognition, face alignment, face modelling, face verification, facial tracking, etc. Start with the basic stage of face detection. Face detection, emotion recognition, face tracking, and posture assessment all require more study. Face identification is challenging since faces alter in size, shape, color, and other features and are not static. Face identification is still hampered by issues such motion blur, differences in position and expression, accessories, occlusion, noise, and thermal imaging, when the subject is not facing the camera, the image is blurry, it is obscured by anything, the lighting is poor, etc.
Biometric traits including fingerprints, palm prints, hand geometry, iris, face, speech, gaits, and signatures can be used to identify humans. The main problem was that although using facial recognition, they required the user to actively participate in the authentication process. Face recognition therefore becomes far more practical than other biometrics.
Face recognition technology can be incredibly useful in a smart campus setting, providing numerous benefits to enhance security, streamline processes, and improve overall efficiency. Some of those ways are Access Control and Security, Attendance tracking, Enhanced Safety Measures, Payment and transactions, Personalized services, Library services, Campus Analytics, and visitor management.
It is essential to note that while face recognition technology offers numerous benefits, privacy concerns must be addressed properly. Campuses should establish clear policies and practices regarding data handling, consent, and security to ensure the responsible and ethical use of the technology.

2. LITRATURE SURVEY

The paper "SVM Based Expression-Invariant 3D Face Recognition System" describes a 3D PCA and SVM-based expression-invariant face identification system. For precise feature extraction, it leverages new MLPs-based registration. The method successfully recognizes near frontal 3D faces with a high rank-1 recognition rate of 96.29%, proving its efficacy [2].

"Design and Evaluation of a Real-Time Face Recognition System Using Convolutional Neural Networks" – The developments in high-speed CPUs and high-resolution cameras serve as the impetus for the paper's real-time facial recognition system, which uses CNN. The system is tested using common AT&T datasets before being expanded for real-time use. It details systematic CNN parameter adjustment to raise recognition accuracy. The suggested system successfully completes facial recognition tasks with 98.75% accuracy on benchmark datasets and 98.00% accuracy on real-time inputs [3].

The study "Face Detection Based on Multi-Block LBP Representation" presents a real-time face detection method using Multi-block Local Binary Patterns (MB-LBP) as differentiating traits. MB-LBP works better than Haar-like and original LBP, with a 15% higher accuracy rate and a false alarm rate of 0.001. Due to a lower feature set, MB-LBP also requires less training time [1].

“Techniques and Challenges of Face Recognition: A Critical Review”-The paper discusses face recognition in computer vision and its importance in various applications. It addresses challenges like facial expressions, pose variations, and occlusion. The authors propose face synthesis to improve accuracy on different databases and review various face recognition techniques. The goal is to enhance efficiency and recognition rates in large databases [7].

“Application Research of Face Recognition”- The paper focuses on promoting campus Informatization to create a smart campus. It highlights face recognition as a key technology with natural security advantages but mentions, the difficulties of expensive equipment and potential data leaks. The research describes a facial recognition-based dormitory management system that exhibits enhanced management effectiveness, accuracy, and dependability. A key component of creating a smart campus is the use of facial recognition in campus administration. revolutionizing traditional work and life processes for teachers and students [9].

Face Recognition Using Fisher face Method – The research focuses on using the Fisher face algorithm for face recognition. It maximizes class separation during training, making it superior to eigenface. The study aims to create a face recognition application using Fisher face with GUI and a database of Papuan facial images. The process involves reducing face space dimension with PCA and using Fisher's Linear Discriminant (LDA) for feature extraction. The algorithm achieves 93% success in recognizing 73 test images with various expressions and positions. When testing images match training images, the success rate is 100%. The implementation is done in Matlab7.10, and images are pre-processed with Adobe Photoshop CS4 to ensure uniformity in size and format [12].

A Study about Principle Component Analysis and Eigenface for Facial Extraction -The paper discusses the application of Principal Component Analysis (PCA) and the eigenface method for facial feature extraction in the field of facial recognition. It evaluates the performance of these methods using accuracy, precision, and recall metrics as a baseline of experimentation. Two public datasets, SOF (Speech on faces) and MIT CBCL Face recognition, are utilized for the experiments. The findings suggest that PCA performs well in terms of the evaluated metrics.

3. DATA SETS

3.1 Bosporus’s 3D Face Data Set Description

4,666 3D facial scans from 105 individuals with a wide range of expressions, positions, and occlusions are available in the Bosphorus database. 2,902 facial scans in all, with 105 subjects' various expressions. The experiment makes use of 105 initial neutral scans from each identity and 2797 non-neutral scans as a gallery set. In this data set, Support Vector Machine (SVM) is employed [2].

3.2 AT & T dataset

The AT&T dataset contains a sample size of 92*112, and there are 400 samples of images. The images are organized in 40 directories, and all are grayscale. Thus, Convolutional Neural Network (CNN) is applied in this data set [3].

3.3 Labeled Faces in the Wild (LFW) dataset

Fisher's Face Algorithm is used on the LFW dataset. 13,233 face photos from the internet are included in the dataset. The 5749 identities in this collection include 1680 individuals who have two or more photos. On 6,000 face pairs, the verification accuracy is stated in the standard LFW evaluation technique [13].

3.4 LFW crop grey data set:

For processing, changed photos are placed into a NumPy array with the dimensions 1000, 64, and 64. The tracking collection included names of both common people and famous people. Instead of 1000 images as in the beginning, there are now just 50 that we can believe in. (eigenfaces. Shape = (50, 64, 64)).

4. Machine Learning Algorithm For Face Recognition

4.1 SVM BASED RECOGNITION

In order to do classification or recognition, the Support Vector Machine (SVM) supervised machine learning technique generates one or more hyperplanes in a high-dimensional space. Finding the appropriate hyperplane that optimizes the gap between any two classes is the goal of SVM learning. Using a binary classifier, SVM effectively splits data into two classes [2]. The margin is the distance between the hyperplane and the closest data points. Support vectors are the data points along the hyperplane's edge. When this strategy is recommended for object identification, the positive samples are assumed to be the object classes among the classes, and the negative samples are assumed to be the non-object classes.

Using quadratic programming, the hyperplane is created from an endless number of hyperplanes for manually generated training samples classified as object or non-object [6]. However, SVM has been used for binary and multi-class classification in the indicated expression-invariant 3D face recognition, and their efficacy has been assessed [2]. Using a non-linear SVM with gaussian and linear RBF (radial basis function) kernels, face scans can be categorized.

The Gaussian RBF kernel, in which the radial (exponential) function soothes the distance measure, is one of the most popular kernel functions [2]. The kernel technique is applied to the characteristics that were extracted from the input. It transforms the data into a high-dimensional space where separability is more likely, changing it from being nonlinearly separable. Finding the right kernel for the given problem is the major challenge, and it is not simple. Every time a kernel is chosen, the classification issue is evaluated on it, and it could not produce as excellent of results as the sample set [6]. SVM classifiers have an edge over conventional neural networks since they perform better in terms of generalization [10].

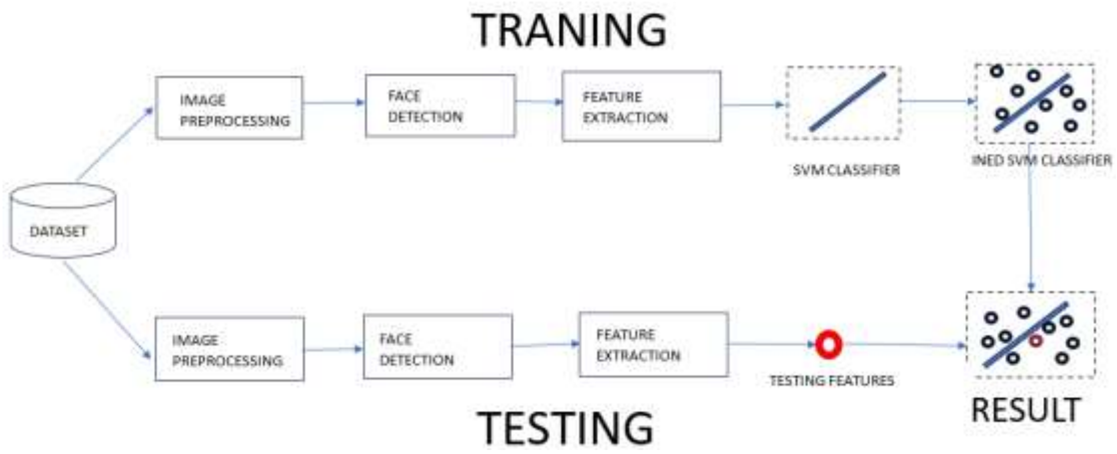

Figure 1: General skeletal structure: dividing the dataset into training and testing sets

4.2 FISHER FACE

Fisher is a linear discriminant that faces or is known as Fisher. The Fisher facial method for facial identification was introduced by Bilheimer in 1997 [12]. It combines Principle component analysis (PCA) and linear discriminant analysis (LDA).
Unlike LDA, which is a supervised algorithm, PCA is an unsupervised method. PCA preserves distribution data but is unable to project the ideal matrix. The Fisher criterion's optimal matrix is projected by LDA, but it cannot be used directly because the input space's dimension is bigger than the number of training pictures [11].

A face recognition system using the Fisher face approach aims to identify the face image by matching the results of its feature extraction. The system is anticipated to decide whether the test image is appropriately recognized.

The purpose of this procedure is to gather data in the form of a face image. Direct photography of the face is used to gather sample data. The face is in an erect position facing the front and is not obscured by any other items. The preprocessing step and the processing stage, which comprises feature extraction and recognition, are the two stages that make up this process' design.

At this step of the image processing process, the Fisher face method will be utilized to create the feature vector for the system's facial image data. The Euclidean distance formula will then be used to compare the training picture's vector of traits with the test image's vector of traits. The technique employed is the Fisher face method, a union of the PCA and LDA techniques. However, this method's flaw is that it loses some discriminant information that is useful for the LDA procedure during the PCA dimension reduction phase [12].

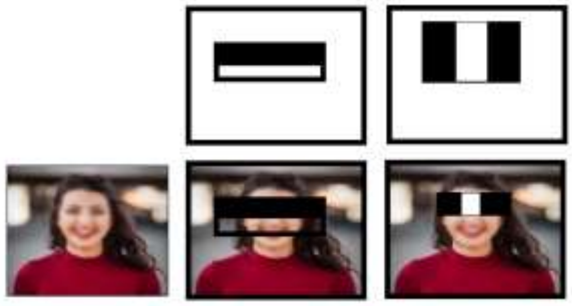

Figure 2: Process of Fisher face

4.3 CONVOLUTIONAL NEURAL NETWORK

Convolutional neural networks are like ordinary neural networks, but by clearly showing that the input is an image, it allows the designer to understand specific objects in the architecture. The CNN architecture used in the system has several layers: INPUT (records raw pixel values), CONV (uses convolutional filters to extract features), RELU (enables hidden units), POOL (does size reduction and down sampling), and FC (all layers for classification). The proposed CNN architecture has been fine-tuned by repeated evaluations to achieve maximum accuracy. After the second CONV + RELU layer, use max pooling with a window size of 4x4 pixels to down sample the feature maps. Next, a DROPOUT layer is introduced to prevent overfitting, where a drop of 0.5 is found to provide the most accurate fit for the application. The later stages of CONV + RELU, POOL and DROPOUT are skipped as they do not provide useful information. The output is then flattened and fed to the CONDENS/FC layer for classification. The size of the last DENSE layer in this study is 5x1, because the system aims to classify five people's faces in real time. Overall, the proposed CNN architecture has proven effective for real-time face recognition. The system leverages the power of deep learning and fine-tuning layers to improve recognition accuracy for specific applications.

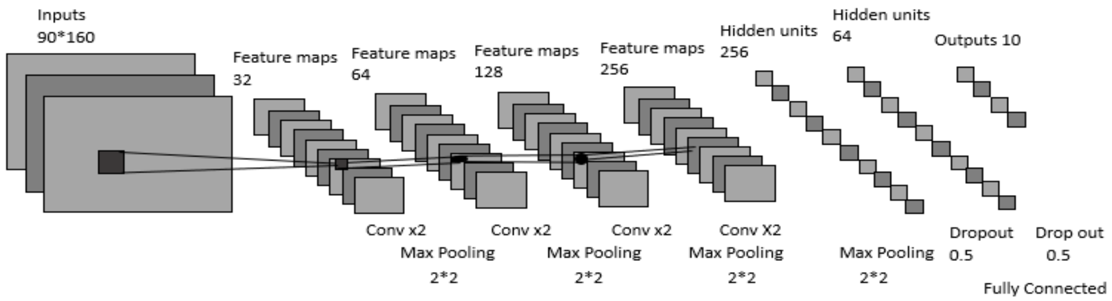

Figure 3: Layer of CNN Model

4.4 EIGEN FACES

Because of its simplicity, speed, and learning ability, the Eigenface approach appears to be a suitable face recognition method. Eigenfaces are a set of feature vectors for the face recognition computer vision issue. They are referring to approaches like facial recognition that try to record variations between facial photographs and use this information to encode and compare images of a person's face holistically [14]. Section When given A, practically all vectors shift direction, as expected. Some x vectors, however, have the same direction as Ax. What do you think? These are our vectors of features. Specifically... Ax and x can be two vectors with different magnitudes but the same direction. This is the same equation as before: Ax = x. The sum of these two is λ, the sum of our sums, a proper number. This tells us how the eigenvectors vary along the equation. The Eigen Faces algorithm essentially uses PCA. The main objective of PCA is to reduce Visualization, feature extraction, data compression, etc. It has many applications. The idea behind this is to linearly project the original data into a low-dimensional subspace, which provides the maximum variance of the data projected into the principal components (eigenvectors) and/or the minimum projection bias error. In the end, both will give the same result and this is the best build formula. As a side note, this subspace is called the main subspace.

Figure 4: Mean Image for Eigen faces

5. RESULT ANALYSIS

The performance of SVM is evaluated using the Bosphorus 3D face database, which contains 3D facial scans of 105 persons in point cloud representation. Although the database contains many diverse facial expressions, only facial scans with complex facial expressions are considered in this work. The assessment makes use of 2902 3D facial scans. The dataset, which ranges in size from 105 to 796 facial scans, is used for training, with the remaining scans used for testing. The accuracy is only 76.33% when just neutral scans (105 scans, one from each class) are used for training. After that, the statistical model is trained using facial scans of persons showing a variety of emotions (5-8 scans for each class), which results in an increased accuracy of 96.2%.

The Fisherface method is a powerful face recognition technique with high accuracy. It achieves 100% recognition for identical test and training images and 93% for different ones. It handles variations in color components, sketches, noise, and blurring. Challenges include scaling and poses, which can be addressed with better scaling and more diverse training images. Overall, Fisherface is an excellent choice for robust face recognition [12].

The performance of CNN is evaluated using 400 images, 320 among which are used for training and the balance of 80 for testing. The assessment is carried out by varying the number of filters in the layer of convolution and the window size of the convolution filter for different pooling window sizes. The proposed approach, which employs pooling windows with sizes of 2*2 and 4*4 pixels, achieves a maximum accuracy of 98.75% using a convolution filter of size 3*3 pixels and 32 filters. Following successful review and testing, the effectiveness of real-time information from the camera is analyzed. A total of 200 photographs were collected, 100 for testing and the remaining 180 for training. The highest recognition rate of 98.0% was achieved in a real-time system using a 32-convolution filter with pooling window sizes of 2*2, 3*3, and 4*4 pixels and different window sizes of the convolution layer [3].

Feature extraction utilizing PCA, preprocessing, and database storage are just a few of the processes that go into the learning phase. During the recognition phase, the system subsequently completes the fundamental tasks of image detection, face detection, and feature extraction. A sample of 1000 photos or faces made up the DATASET. An outcome of facial recognition.

Accuracy, recall, and precision metrics are calculated for the experiment using PCA and eigenface.

Accuracy = (TP+TN)/(TP+FP+FN+TN)

Recall = TP/(TP +FN)

PRECISION = TP / (TP +FN)

The results of recall, precision, and accuracy calculations for the face database
The Eigne faces, when used, gave us a true positive of 7.3, a true negative of 6.6, a false positive of 2.7, and a false negative of 3.4.
The algorithm also gave us a recall of 0.598, Precision of 0.63, and Accuracy of 5.95.

6. CONCLUSION

In conclusion, the research paper delved into the exploration and analysis of four prominent face recognition algorithms: Fisher Face Algorithm, Eigenfaces Algorithm, Support Vector Machines (SVM), and Convolutional Neural Networks (CNN). Each algorithm demonstrated varying degrees of accuracy in recognizing faces within a given dataset.
The Fisher Face Algorithm exhibited an impressive accuracy of 93%, showcasing its effectiveness in discriminating between different facial features and capturing essential variations for face recognition tasks. However, it fell slightly short compared to some other methods, possibly due to the sensitivity to variations in facial expressions and lighting conditions.
The Eigenfaces Algorithm, with an accuracy of 60%, performed reasonably well but showed some limitations in handling complex facial variations, leading to a lower accuracy compared to other more sophisticated approaches. Despite its simplicity, Eigenfaces provided a valuable foundation for understanding facial feature extraction and dimensionality reduction.
Support Vector Machines (SVM) proved to be a robust and reliable choice for face recognition, achieving an accuracy of 96.2%. SVM's ability to create optimal hyperplanes for class separation makes it an effective classifier for facial recognition tasks, and it showcased promising results in this research.
The standout performer in this study was the Convolutional Neural Network (CNN), with an outstanding accuracy of 98%. CNNs are well-known for their ability to automatically learn hierarchical features from raw data, and in the context of face recognition, they demonstrated unparalleled performance, showcasing their potential as the state-of-the-art approach in this field.
In conclusion, the study underscored the importance of selecting the appropriate face recognition algorithm based on the specific requirements of the application. While simpler methods like Eigenfaces and Fisher Face Algorithm can be valuable for certain scenarios, SVM and CNN offer substantial advantages in achieving high accuracy and robustness in challenging face recognition tasks. As technology continues to evolve, further advancements in these algorithms are expected, pushing the boundaries of face recognition capabilities and opening new possibilities for real-world applications. Researchers and practitioners should keep exploring and refining these techniques to harness the full potential of face recognition technology across various domains, including security, surveillance, and human-computer interaction.

7. FUTURE SCOP

Face recognition is a sophisticated technology that may aid the community in recognizing suspects, hence it is suggested that identity management be investigated using CNN. This technology's application might be expanded to handle sensitive materials and manage libraries, among other things. Other procedures may not be employed due to the risk of disease spread by Covid-19. In contrast, facial recognition would scan your face, run it through a system, and ask you for information. This may make obtaining information easier.

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