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Analysis of Face Recognition Methods

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ABSTRACT-Face recognition has emerged as a promising field in computer-based applications in recent years, owing to the wide range of applications that it has found in a variety of fields. Due to the obvious wide variety of variances across people's faces, face recognition utilizing database photos, actual data, record images, and sensor photographs is a tough task. Image segmentation, cognition, and data analysis, to mention a few areas of research, all have ties to facial identification. The development of new techniques associated with face authentication technologies is an ongoing process that contributes to the development of more long-lasting face recognition algorithms. Many facial recognition techniques are often divided into two categories: feature-based approaches and holistic methods. At the present, there is a relatively small number of research that have been conducted that have linked both of these techniques. Face recognition algorithms have been developed in large numbers over the course of the past few decades. The purpose of this article is to provide a systematic evaluation of a wide variety of facial recognition methods that are currently on the market. This includes neural networks, fuzzy-based methodologies, and the eigenvalues approach, among other things.

KEYWORDS-Algorithms, Face Recognition Techniques, Deep Learning, Neural Networks, Pattern Recognition.

I. INTRODUCTION

Comparing face recognition to other biometric-based systems, facial recognition has emerged as a standout among the most important applications in recent decades. When one enters a face photo into a database that contains numerous face images of known individuals, the technique aims to confirm or identify the name of the people shown in photograph. As an alternative to using usernames, PINs, memory cards, token, keys, and other photo identification such as face recognition software to verify users and enable them access to virtualized areas, biometric-based techniques have been created. This method of examining a person's physical and behavioral features is used to try to figure out who he or she is. In contrast to passwords and PINs, which may be difficult to remember and can be stolen, cards and other tokens, keys, and so on can be misplaced, ignored, or duplicated[1].

People's biology cannot be lost or stolen or manufactured by any means other than their own natural biology. Personal characteristics such as face recognition, prints, finger geometry, finger veins, palm, eye, ear, and voice may be used in biometric approaches for personal identification or recognition, particularly in surveillance systems. Due to recent technical advancements in various fields, including the smart environment sector, the number of police application has grown significantly over time. When it comes to face recognition for identification purposes, facial traits are recognized as a crucial factor in the area of biometrics. In order to achieve automatic identification, it is necessary to create a face database. A large number of photos are taken for each individual, and their characteristics are erased before the photographs are placed in the database. When the input face image is received, we do face recognition and feature extraction on it, and we compare it to every facial class that has been recorded in the database. A variety of works and methods have been proposed in order to solve the categorization problem in issue[2].

This has also been a significant topic in both science and business, as it pertains to the correct and effective classification of people. In recent years, face recognition has gained in prominence as a result of the rapid advancement of artificial intelligence technology. While classic face recognition, fingerprinting, and iris detection all have their merits in terms of accuracy and ease of use, face recognition offers a number of distinct advantages over these other biometric methods. A wide range of businesses, including as banking, public utilities, the military, online shopping, and education, have high hopes for this technology.

This section of computer education is one of the most essential in modern times. Deep learning, on the other hand, pertains to the use of various deep learning methods in cross neural network models in order to address specific issues, such as image processing and data analysis. As a deep net in the broad sense, deep learning enables a number of functional awareness upgrades. It is at the core of deep education that functional learning tries to gain hierarchical knowledge through hierarchical networks to meet the

pressing concerns that artificial innovation was previously needed to answer. There are several essential algorithms that make up Deep Learning [3].

A company that uses a test system does not need a variety of biological traits to be successful. Based on the aforementioned advantages, biometrics has piqued the attention of many people and has begun to replace current identifying methods in a variety of settings. In order to provide automated control, and it is easy to integrate into people's daily life as machine and artificial intelligence become more sophisticated and sophisticated.

It is possible to observe that face recognition costs are low, consumer acceptance is easy, and knowledge gathering occurs quickly when comparing the differences across biometrics when looking at their variants. A facial recognition system use machine vision and related methods to identify faces in photos or recordings, and then analyses the faces to determine their identities. Further study of the acquired face may frequently reveal a variety of other features, such as race, age, and mood, which might be helpful[4].

The Facial Recognition System (FRS) can now automatically identify people who appear in videos and digital images, which is an important security tool. Face recognition methods have recently been the attention of a large number of researchers. In a person identification application, the human face is a distinguishing and important characteristic. It seems to have a few advantages over other biometrics that are worth considering. Many other methods are employed, but almost all of them necessitate the participation of the client in some way, for example, For fingerprints and hand shape location, the client must put his or her finger on a hand-rest, and the person must stay still before a camera enabling iris or retina identification. Because the photographs are taken from afar by a camera, that should be possible to use facial recognition in a passive way, without the member having to engage in any kind of activity or involvement. Face recognition technology has various drawbacks, such as coarse contrast, light, volatility in the person's posture, and illumination change. People may not perceive their own faces in this situation.

Consequently, researchers have the chance to build a new way to overcome these shortcomings, which would improve safety and enable them to investigate new methods of facial recognition software improvement. The idea underlying the technique of facial recognition is to distinguish between known and unfamiliar pictures, and thus a face recognition system use pattern recognition to accomplish this. Because of the difficulties in identifying individuals, such as the complexity and pose of their faces, as well as the scarcity of knowledge in the field of pattern recognition, artificial intelligence and computer vision propose a variety of solutions to improve precision and robustness of identification. In recent years, biometric-based security solutions, particularly in the area of face recognition, have seen a substantial rise in the number of users. Additionally, face recognition applications are an effective and accurate method of providing personal security in a variety of settings, included in this is a smart house, a smart card for access, security, and entertainment. Techniques to reducing dimensions include topic identification and data-driven algorithms. With the answers to the comprehension of topics, the feature of the fundamental case of pattern recognition by means of knowledge becomes more apparent. For example, the discrete Fourier transform (DFT), the discrete Cosine transform (DCT), and inconspicuous features Because the human audio and visual experience reacts more significantly at shorter wavelengths than at higher frequencies, wavelet transforms are extensively utilized in photo editing and audio signal processing. Using the language in text retrieval involves the use of the geographical context of languages, another key example. Different from domain knowledge methods, some types of machine learning algorithms directly extract useful characteristics from the training data via data-driven approaches, which is in contrast to domain knowledge approaches[5].

A. Face Recognition Process

Face recognition is a routine and seamless activity that people do on a daily basis in their daily activities. The facial recognition technique is the process of identifying a person's face using data that has been entered into the system. A simplified representation of facial recognition is shown in Figure 1:

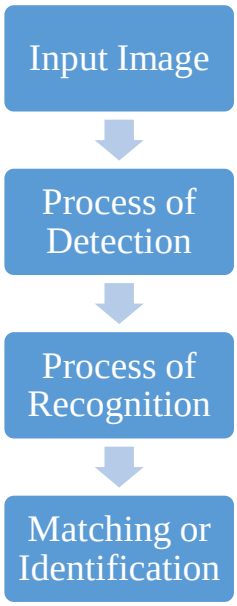

Figure 1: The Steps involved in Face Recognition

Authentication and facial recognition may be performed using holistic approaches that take into account all of the faces in a collection. There are a limited number of features that can be directly obtained from the cells of a face photo that can be depicted by using global details. It's just a small lot of major details that reflect these characteristics. These characteristics are responsible for clearly differentiating and reflecting the differences between the numerous face pictures and, as a result, for identifying the person as a single individual[6].

B. Eigen-face Method

The Eigen-faces techniques, also known as Eigenvector or Principal Component Analysis (PCA) methods, are the broadest methods of face identification available. Faces may be easily rebuilt by taking into account just a small quantity of information gathered via the use of Eigen faces. The covariance matrix is a representation of the key components that partition the surface into function vectors. Using these vectors, it is possible to calculate the degree of variation between distinct facial features. In this case, a linear combination of the maximum values of the Eigen is used to identify the faces. Due to the background noise, the low facial recognition score and Eigen characteristics such as the ears, nose, mouth, cheeks, and so on may be utilized in place of Eigen faces, which is a good thing. This technique is less sensitive than the Eigen face strategy, in contrast to the Eigen face strategy. In this scenario, the gadget achieves a 95% accuracy in identifying the user. Shortly said, the most accurate, fastest, and most effective Eigen face solution is typically the one that provides invariance data even when the illumination and scaling circumstances are changing. It has been developed in recent developments to improve the efficiency of the face recognition system, which uses MPCA for facial image preprocessing and LPP for facial feature extraction. The technique is based on multi-linear main component analysis (MLMCA) and locality preservation projection (LPP). With the key component analysis (PCA) Eigen face method, we can reduce the dimension and select vectors with the best meaning to distribute the face picture in the input face space, while still maintaining accuracy. It establishes the existence of a subspace known as face space, as well as the projection of a training set into face space in order to discover a weight set that reflects the vector's contribution to face space[7].

C. Neural Networks Method

Simplicity in the form of artificial neurons influenced by the human brain has discovered that perceptron is linked to one another in many levels, similar to how the brain works. The summation function of a mathematical function or the threshold function of a mathematical function are the building blocks of each perceptron. This is a network of self-learning that has been qualified and is not setup in a traditional manner. Face recognition uses a neural network to analyze each as well as every frame (which is severely restricted in terms of size) to determine whether or not it contains a picture of a face. As a result, the computational difficulty is reduced since it does not need preprocessing for non-face images. The following procedure is divided into two stages. In the first phase, the picture region is given as an input to the neural network's filter, which then does the necessary processing. The output of this filter changes between [-1, 1] depending on whether or not the ears are present. The filter is applied to all areas of the picture in order to identify faces. For better performance, For better performance, the system must be made more efficient and the erroneous detections found in the first stage resolved in the second phase. A single neural network may aggregate several overlapping detections into a single detection, making this conceivable [8].

D. Fuzzy Pattern Matching Approach

This method makes use of fuzzy theory in order to represent complicated, non-exact, ambiguous, and inconsistent information or facts. And in order to make a judgement, data from several fuzzy sets is combined. Faces may be identified in colour photographs using the fuzzy principle, where two fuzzy models are used to characterize the skin and hair colours, and a consistent colour space is utilised to describe the colour details in order to increase accuracy and stability in the identification process. The skin- and hair-colored sections of the template were cut away using two separate copies of the template. In this way, fuzzy theory-based algorithms for pattern matching may be used to compare human faces to certain pre-built models that can distinguish human features from one another. The processes of composition and defuzzification serve as the foundation for fuzzy reasoning. It is possible to recognize faces by using fuzzy reasoning in the setting of a fuzzy machine model consisting of power, response, fuzzy sets, and operational data variables, hedges, and fuzzy; as well as a control process and a fuzzy machine model[9].

E. Spatially Invariant Feature Matching

Local feature characteristics, such as curving values or other debt information, is used in certain contemporary feature matching approaches to ensure reliable performance and dependability. Using the similarity measures of the function in situations where the performance evaluation offered by the various scanners is not constant is impossible because of this dependency. Simply looking at the feature parameters from each facial landmarks detector simplifies the spatial invariant feature matching (SIFM) procedure for all detection systems. The recommended approach is invariant to nationally and internationally deformations due to its foundation in evolutionary divergence methods with invariant characteristics. Additional to this, a geometric invariant theory-based SIFM approach is used [10].

II. DISCUSSION

Face recognition is an essential component of the capacity of the human perception system and is a regular job for humans, while developing a computational model of face recognition that is comparable to human perception system. Besides providing theoretical insights, the computational model has applications in many practical areas such as automated crowd surveillance, access control, design of human computer interfaces (HCI), content-based picture database management, criminal identification, and so on. Face recognition research dates back at least to the 1950s in psychology and to the 1960s in engineering literature, with the first published work dating back to the 1950s. Some of the first research were conducted on the emotions expressed via facial expressions. However, research towards automated machine identification of faces began in the 1970s, after the foundational work of a number of scholars. In 1995, a review

article provided an in-depth examination of facial recognition technology as it existed at the time. During that time period, the technology of video-based facial recognition was still in its infancy. The field of face recognition has gained increasing attention in recent decades, as well as technological advancements. There is a plethora of commercial solutions for still face recognition currently available. Recent research has concentrated on video-based face modeling/tracking, recognition, and system integration, with particular emphasis on system integration. Several new databases have been developed, and assessments of recognition methods have been carried out on the basis of these databases. Face recognition has risen to become one of the most widely used applications of pattern recognition, picture analysis, and comprehension in recent years.

It is the automatic recognition of a person on the basis of a physiological or behavioral feature that is known as biometrics. History of biometrics involves the identification of individuals by distinguishing physical characteristics such as scars or by a combination of other physiological characteristics such as body height, eye color and complexion. Face recognition, fingerprints, handwriting, hand geometry, iris, vein, voice, and retinal scan are some of the characteristics that are now available. The biometric method is currently being used as the basis for a broad range of highly secure identification and personal verification applications. Due to the rise in the number of security breaches and transaction scams, it is becoming more obvious that well-secured identity and personal verification technologies are required. Recent global events have sparked a renewed interest in security, which will eventually lead to the widespread use of biometrics. Internet transactions, workstation and network access, telephone transactions, and travel and tourism are all examples of areas where this technology will be used in the future. There are many distinct kinds of biometrics: some are ancient technology, while others are cutting-edge. Fingerprinting, retinal scanning, hand geometry, signature verification, voice recognition, iris scanning, and face recognition are some of the most well-known biometric technologies.

Face recognition is a unique case study in pattern recognition, and it has had significant implications in everyday life, particularly for security reasons. Face recognition technology is now in use at airports, employee entrances, criminal detection systems, and other locations. There have been numerous techniques suggested and tried for this job, including elastic matching, neural network-based approaches, Independent Component Analysis, and Eigen-faces, among others. The majority of these techniques involve trade-offs, such as hardware requirements, time required to update the picture database, time required for feature extraction, and response times. A feature extractor (such as PCA or Wavelet decomposer) is used to decrease the amount of the input data, and a classifier (such as Neural Networks, Support Vector Machines, or Nearest Distance Classifiers) is used to identify the features that are most likely to be searched for. As the primary methods for data reduction and feature extraction in this research, we used wavelet decomposition and the Eigen-faces method, which is based on Principal Component Analysis (PCA). PCA is an efficient and well-studied technique for extracting feature sets from a feature space that has been around for a long time. PCA also has the benefit of having a short calculation time, which is a significant advantage. PCA, on the other hand, is inefficient since it is a linear feature extraction technique, which is particularly true when there are nonlinearities in the underlying connections that must be considered. This multilayer dimension reduction method does time–space–frequency analysis, and it is known as wavelet decomposition. In contrast to the Fourier transform, which only offers frequency analysis of signals, wavelet transforms provide time–frequency analysis of signals, which is especially helpful for pattern recognition applications.

III. CONCLUSION

In order to identify faces, holistic methods depend on a global understanding of the human face. However, one disadvantage of this strategy is that the variations recorded may not represent significant facial features. Since the position, expression, and lighting conditions of a face may change widely, it is a difficult challenge to tackle. For the purpose of this article, we wanted to evaluate the most recent holistic face-recognition techniques in additional to the more conventional approaches. The patented face-based approach is one of the complete methods, while others include spatial matches sensor, neural network system, and fuzzy theory technique. The main advantage of holistic techniques is that they gather the most prominent characteristics from the supplied face pictures independently, allowing them to categorize people from a given set individually and even find features automatically, as opposed to traditional methods. The drawbacks, on the other hand, are that the effectiveness of facial recognition may be significantly affected by factors such as lighting, orientation, and characteristics revealed by faces that do not constitute a part of the face but have been captured by certain other features. For example, features from the context of a face picture may be used. To construct a global face-recognition technology that can handle all of the available facial recognition variables, an integrated method may be explored.

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