Recognition of Faces Based on Images

Serri Ismael Hamad*

College of Education for Pure Sciences, University of Thi-Qar, Iraq

Abstract. *Systems for identification have existed for a very long time. Thanks to computers that use biometric facial recognition, these recent advancements have helped identify people, grant access to private websites, and improve security and order in all areas. This technology only uses pictures of people's faces. Information identical to that used in facial recognition can be obtained by extracting each person's traits. The different steps, phases, and techniques for obtaining the characteristics that comprise facial recognition systems will also be covered in this study, along with the advantages and disadvantages of their use, the criteria for individuals, and their positive and negative aspects.*

Keywords: *Algorithms, Biometrics, Facial Recognition, Feature Extraction, Privacy*

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**Correspondence:*
Serri Ismael Hamad
serriismael@utq.edu.iq

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INTRODUCTION

Facial recognition has developed rapidly. Since Alphonse Bertillon laid the foundations for facial recognition in 1883, it has been based on a number of anthropometric measurements, such as eye distance, symmetry, and an individual's facial features. This system is a trend in the forensic field and has even reached the point of being used in courts of law, as it can accuse or prove innocence in people with a criminal record (Sanchez-Moreno et al., 2021). Facial recognition is a much more powerful version of the technology used in mobile phones or computers to identify friends in photos. Using it to identify people and verify their identities can simplify access control to government buildings and businesses. Some systems can identify known or suspected criminals, and companies can analyze their customers' faces to customize marketing strategies. However, there are also serious privacy concerns, as this technology can be used to track individuals across their communities and even around the world.Facial recognition is arguably a very important tool in the media, as it allows an individual to be identified by certain characteristics. While facial recognition is sometimes useful, it should not be forgotten that the misuse of facial recognition significantly impacts individual development. Surveillance is also a major driver of growth, meaning governments are a major source of revenue (Li et al., 2021).

1. How Facial Recognition Works

Advances stem from the study of biometrics, and this, combined with technology, results in the taking of measurements and analysis of biological data such as DNA, handprints, irises, and voice (biometric tasks). This is how facial recognition systems were born, which make their identification decisions using each person's personal characteristics (photographs and videos) and capturing them in a digital image, which can then be automatically recognized or verified by a computer.

"Biometrics are designed so that you You don't have to do anything. The device simply recognizes you." (Li et al., 2021).

On the other hand, the recognition process uses algorithms (which analyze hundreds of faces and use a facial mapping that captures 100 facial expressions) for image processing. All images are 50 x 50 pixels wide and high, and have a directionality of 2,500 pixels, thus increasing their computational cost (Arguello, 2011).

Considering feature extraction techniques, some of the existing components were analyzed:

a. PCA (Principal Component Analysis)
b. LDA (Linear Discriminant Analysis)
c. LPP (Locality Preserving Projections)
d. DCT (Discrete Cosine Transform)

PCA is a dimensionality reduction algorithm that allows for finding the vectors that best represent the distribution and classification of a group of images. The objective of this approach is to represent an image in terms of an optimal coordinate system, reducing the final number of components that the image will have (Kim et al., 2020).

Mean while, LDA performs well when the measurements made on independent variables for each observation are continuous quantities. The objective is to project a data set into a lower-dimensional space with class separability to avoid overfitting and also reduce computational costs. When dealing with categorical independent variables, the equivalent technique is discriminant correspondence analysis (Penton-Voak et al., 2006).

In LPP, graphs are assembled that include neighborhood information such as the data set. The graph representation generated by the algorithm can be viewed as a discrete linear approximation to a cone that arises naturally from the manifold geometry.

In DCT, a finite sequence data transformation is provided as the sum of cosine functions oscillating at different frequencies (Kim et al., 2020).

In DCT, image features are obtained and then used for classification, as is done with PCA, so the basis of DCT is independent of the images.

2. Stages of Facial Recognition

By including facial recognition systems, five stages are highlighted:

a. Face detection.
b. Conditioning.
c. Normalization.
d. Feature extraction.
e. Recognition.

Detection locates the facial region (if it exists) and segments it from the rest of the scene. Conditioning locates the components and the scale at which the face is found, using geometric transformations. Following the process, normalization consists of normalizing the images in the pre-processing stage so that the effects are attenuated of lighting changes, that is, matching the size and intensity of a given range, among other factors, and thus performing scaling and cropping with a rectangle or ellipse.

Feature determination provides the necessary information to differentiate between different people's faces based on their geometric variations. Finally, recognition produces the facial pattern extracted from the features and compares it with the database. If a 90% similarity is found, the face is identified; otherwise, it is indicated as an unknown face, Fig.(1) (Huang et al., 2020)

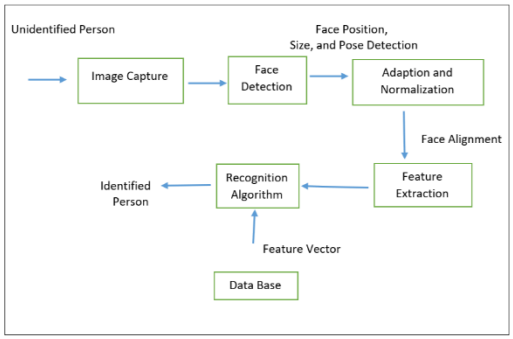

Figure 1. Facial Recognition Process

There are also other strategies for detecting faces, such as eye position, symmetry, or the different facial features of each Or classifiers based on neural networks (Xiaoli et al., 2011).

In other cases, when the normalization process is reached, information from the eyes, nose, or other parts of the face is used, along with biometric information, or only a scaling of the image is performed. Recognition systems that perform these aforementioned operations are known as localization systems. It is not always easy.

To determine the facial regions, one begins by extracting the features, so any of the aforementioned recognition techniques is used. Usually, a given operation produces reduced-dimensional feature vectors that must be compared with the previously compiled database of people. If a person is identified by any recognition method, such as a code, access cards, or other systems, it is known as an authentication or identity verification system (Mollahosseini et al., 2019).

In this process, the test feature vector is compared to the database. If it matches the measurement, the individual is identified; if not, it is a different person. This includes Mahalanobis, cosine of the angle between vectors, fuzzy systems, correlation coefficient, among others. Of all the distances, the smallest are chosen and compared with the initially selected data to determine whether the person is in the database or an intruder. What is notable is that several authors implement various techniques to perform feature extraction and reduce the dimensionality of the problem.In this way, an image-based facial recognition system is obtained. The first experiments with this technology date back to the 1960s, although, at that time, the research leading up to its development was kept secret (Wolffhechel et al., 2014). Unfortunately, it lacks reliability for several reasons, such as the lack of a unified criterion or the possibility of failure, as taking measurements manually would not be as viable.

These advances are applied in numerous places. Among the most important are:

a. Quantity verification, for example: at ATMs, access to buildings, etc.
b. Surveillance, security, and tracking of people.
c. Improved human-computer interaction, for example: a computer that recognizes who is using it.
d. Identification of criminals in police files.
e. The objectives of facial recognition are:
f. Verification or authentication of faces: compares one image of the face with another
g. image of the face we want to identify. The system will confirm or reject the facial identity.
h. Facial identification or recognition: compares the image of an unknown face with all images of known faces in the database to determine its identity.

Table 1. Advantages and Disadvantages of Facial Recognition

Advantages	Disadvantages
Useful in forensic settings	Privacy disruption
Controls access to private locations	Lighting (interior/exterior)
Does not require physical contact, etc.	Occlusion from sunglasses, etc.

Facial recognition is one of the less innovative systems, with biometrics being a fundamental part of it. In this sense, people react to this paradigm because its effectiveness is less than 85%. They also argue that fingerprint detection systems are more effective and less likely to compromise the privacy of people moving through public spaces (Rule & Ambady, 2010). The debate is long, and ultimately, governments will decide which carries more weight: people's privacy or their security (Todorov et al., 2015). Since then, facial recognition systems have been found everywhere, including in public places and shopping malls. Sometimes, they appear on social media when photos are uploaded, capturing facial biometric data (Ahonen et al., 2006).

METHODS

The methodology for this article was based on research in books, websites, blogs, and other research sources. Documents in this area have been read, analyzed, and summarized. From the outset, the study of biometrics was fundamental to the development of facial recognition systems. Subsequently, the following steps were followed, which were continuously reviewed until the end of the research. The steps followed were:

a. Definition of the research title.
b. Description of all topics related to the title.
c. Classification, analysis, and interpretation of documents.
d. Description of each literary content.

Going through the stages of preprocessing, visualization, segmentation, feature extraction, and facial recognition using the different techniques indicated and

described above in a clear and understandable way for the reader.

RESULT AND DISCUSSION

A. Results

The study of facial recognition from images demonstrated its importance. Therefore, a survey was conducted on 50 randomly selected individuals to determine the benefits of facial recognition, which will contribute to the research.

Table 2. Importance of Facial Recognition

Alternatives	Percentage	Answers
YES	45	80%
NO	5	20%
TOTAL	**50**	**100%**

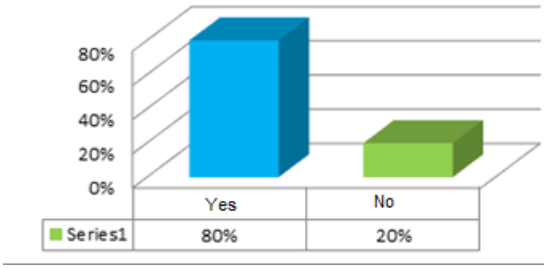

Figure 2. Importance of Facial Recognition

80% Twenty percent of participants answered yes, while 20% answered no, indicating that the majority of participants believe facial recognition is important.

Table 3. Contribution to resolving issues

Alternatives	Percentage	Answers
Yes	49	90%
NO	1	10%
TOTAL	50	100%

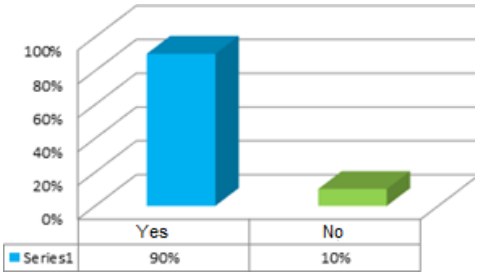

Figure 3. Helps Solve Cases in the Country

Of the 100% of people surveyed, 90% responded that facial recognition helps solve criminal cases in the country, while 10% of those surveyed responded that it does not. Therefore, it can be interpreted that facial recognition is extremely important today, as it allows a person to be recognized simply by identifying a specific individual.

Do you think facial recognition is important today?

Table 4. Importance of Facial Recognition

Alternatives	Percentage	Answers
Yes	42	84%
NO	8	16%
TOTAL	50	100%

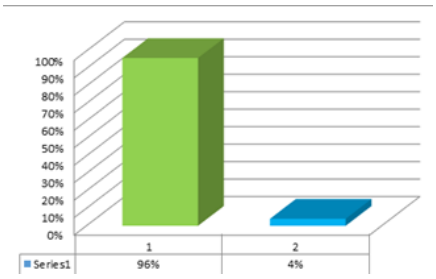

Figure 4. Importance of facial recognition

80% of respondents answered affirmatively, while 20% of respondents answered negatively, meaning that the majority of respondents believe that facial recognition is important.

Are there data protection provisions for facial recognition?

Table 5. Protection of facial recognition

Alternativas	Respuestas	Porcentaje
Yes	48	96%
NO	2	4%
TOTAL	50	100%

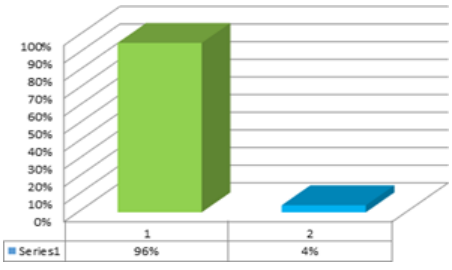

Figure 5. Data Protection

10% of people mentioned that there is a data protection requirement for facial recognition, and 90% of people mentioned that there is no such requirement. Therefore, the study will greatly contribute to raising awareness of the topic.

B. Discussion

This document demonstrates different techniques for extracting facial features corresponding to movements and deformations. It is difficult to compare facial expression recognition systems due to the way the results are presented and the different databases used. One disadvantage of most of the methods presented is that they were tested on frontal-view images taken under controlled conditions, which poses a challenge when implementing a real-life human-computer interface application.

CONCLUSSION

The study determined that there is no specific facial recognition technique that meets all the expectations of the case. It was also revealed that it helps in the fight against crime. The research shows that 90% of respondents agree with this. In the fight against terrorism, facial recognition changes people's perceptions of privacy in the blink of an eye.

Furthermore, it was established that facial recognition is a computerized system that automatically identifies a person based on a digital image or video source contained in a stored database. Thus, the advantage is that it allows people to respond to the faces they see rather than having to break them down into parts.

Current recognition rates for research using a single feature extraction technique are around 90%. Industrial implementations using the FERET database for testing have a performance of approximately 99.99% with a false acceptance rate of just 0.001%. These values should be taken into account when considering any future implementations.

It was also found that the most commonly used techniques in research are PCA and any of its variations, CPCA or KPCA, and artificial neural networks (ANNs). Within the latter technique, researchers primarily use support vector machines (SVMs), radial basis functions (RBFs), and, in some cases, multilayer perceptrons (MLPs). It was also found that DSPs are one of the preferred hardware options for real-time implementations, and that there is a variety of work based on the Texas Instruments C6000 architecture. No real-time implementations of applications based on 3D head models were found; this could be an area of research for future work.

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