E-ISSN: 2676-6167 | P-ISSN: 2538-5100

Journal of Applied Research on Industrial Engineering

www.journal-aprie.com

J. Appl. Res. Ind. Eng. Vol. 8, No. 2 (2021) 169–175.

Paper Type: Review Paper

A Short Survey on Face Recognition

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Citation:

Arora, V., & Afnas, T. (2021). A short survey on face recognition. *Journal of applied research on industrial engineering, 8* (2), 169-175.

Received: 07/01/2021 Reviewed: 06/02/2021 Revised: 08/02/2021 Accepted: 10/04/2021

Abstract

Face recognition has received a great deal of attention over the past few years and has become one of the most researched and spoken topics. It is a kind of automated biometric distinguishing approach that recognizes an individual based on their facial characteristics. The main aim of face reorganization is to implement the system for a particular face and distinguish it from a large number of stored faces with some real-time variations as well. Face recognition is in trend these days, the main reason being its efficiency and vast applications in day to day life. Most all the Telecom companies provide an option to unlock the phones by recognizing the face, which is a time saver and gives protection from theft as well. There are many more such applications of this technique that will be discussed in this paper along with the methods used for face recognition.

Keywords: Face recognition, Face detection, Knowledge-based, Feature-invariant, Template matching, Appearance-based.

1 | Introduction

The enhancement of science and technologies has made life more comfortable than in older days. The emerging technologies like neutrosophic shortest path [1]-[5], transportation problem [6]-[8], uncertainty problem [9]-[14], fuzzy shortest path [15]-[19], Powershell [20], wireless sensor network [21]-[28], computer language [29] and [30], neural network [31], routing [32], image processing [33] have made the products more intelligent and self-healing based. Smart city applications like smart water [34] and [35], smart grid, smart parking, smart resource management, etc. are based on IoT and IoE technologies [36]-[39]. In recent years due to the advancements in the technical world, Artificial Intelligence has been a much-spoken topic which has led to a rise in technological standards. If not for AI, face recognition would not have been a go-to feature in our lives. Facial recognition is a technique used to identify a face from a video or an image or a pre-stored database [40]. Face recognition technology has become vital since it has proved its

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10.22105/jarie.2021.266255.1239

efficiency for augmented security without alerting the person. With the help of an automated face recognition system, it is easy to identify and recognize humans that have found numerous applications such as identifying a criminal, surveillance systems, verification of credit cards, identifying at ATMs, and many more which indeed could lead to a good background check. In the present scenario, it is one of the most convenient ways of identifying a person as there is no physical contact involved in it. There are chances that our security can be hampered due to security hacks such as at times passwords can be stolen also instances are there where they are forgotten, keys or cards can be stolen or misplaced then it is very difficult to recognize one's identity but it is not in the case of face recognition, as biological traits of a person cannot be forged, misplaced, stolen or forgotten [41]. Also using face recognition systems are non-disruptive and causes no health risks.

The human face plays a great significance in our social interactions, portraying one's identity. The salient features of a human face are eyes, nose, mouth, chin, forehead, lips which differentiate one from another and these are the basis of the recognition.

There are various techniques, algorithms, and methods used to recognize a face. Some of the methods are discussed in this paper.

There are 3 functions involved in the face recognition process [42] and [43]:

- *Face detection: face detection also known as facial detection is an AI-based computer technology that is applied to find and identify a human face from digital images.*
- *Feature extraction: feature extraction consists of segmentation, image rendering, and scaling of face prepared for identification. It is mainly reducing the data set and preparing for face recognition.*
- *Face recognition: facial recognition is when the detected face is analyzed and compared from the pre-stored databases.*

The basic flow of the face recognition is shown in the below diagram.

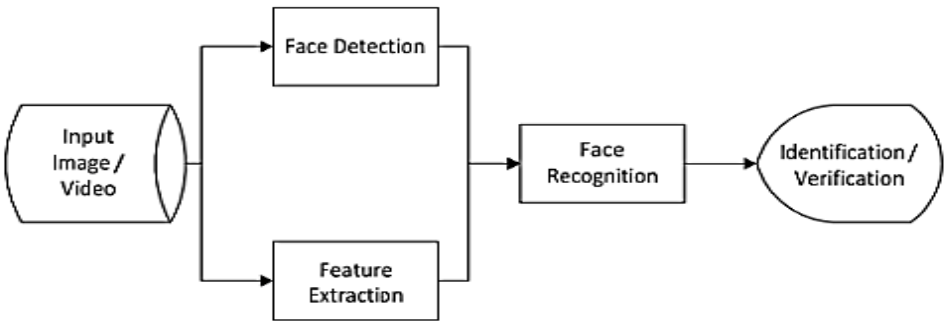

Fig. 1. Flow of face recognition.

2 | Review of Face Recognition Methods

Over the years extensive work has been done on face recognition techniques, methods. It has become one of the most favorite topics of research or study by the researchers. There are many methods and algorithms used to detect and recognize a human face. A few of them are discussed below [44]-[46]:

- *Knowledge-based methods.*
- *Feature-invariant methods.*
- *Template matching methods.*
- *Appearance-based methods.*

2.1 | Knowledge-Based Methods

In knowledge-based methods our knowledge or understanding of the human face is encoded. These methods are termed rule-based methods. These models apprehend our understanding of faces and transfer it into a set of rules. Constructing a suitable set of rules is a big task with these methods as facial traits of human beings remains the same but the facial features of one can differ from another. For example, the color of the skin varies like a person may have dark under eyes when compared to the color of the cheeks and forehead. These methods are developed specifically for face localization, which focuses on determining the position of the image of a single face. There can be a possibility if the rules are too detailed which can confuse the model and hence in turn produce negative outputs. The solution is to construct hierarchical knowledge-based methods to avoid these problems.

2.2 | Feature-Invariant Methods

Feature variant methods tries to find the mutable features of a human face irrespective of its position or angle. This algorithm aims to find primitive features that exist even the lighting conditions, the pose or viewpoint are varying and finally locate faces based upon these results [47]. It is assumed that humans can easily detect objects and faces irrespective of the background condition such as varying poses or different lighting conditions, but the same is not with the systems. They have to be trained to identify different images or faces regardless of their background conditions. When compared to the knowledge-based methods, the feature invariant approach initiates at the feature extraction process. The knowledge-based methods derive information from the complete image and are fragile to the complex background and other influencing factors.

2.3 | Template Matching Methods

In Template matching methods, the input images are compared and analyzed with the saved patterns of human face and features. In template matching methods we must decide the template's features, shape, and size prior [48]. As the name suggests, a template of the face can be modeled by edges. The distinguishing features of the human face are face, eyes, and nose. In these methods, the facial features are recognized for a test face they are equated with the images stored in the database which returns matching scores via normalized cross-correlation. The global score is obtained by accumulating and integrating the scores of the different features. After the scores are assessed, a test face is allotted to the face class with the maximum score [49]. This can a long process as a face has to be compared with all the stored faces and may not be 100% accurate as it compares the template and finalizes the results on the matching score. Also, this method is limited to the frontal of the faces, hence the side faces images cannot be analyzed.

2.4 | Appearance-Based Methods

Appearance-based methods have received noteworthy attention from a broad range of research areas like pattern recognition, machine mining, biometrics, and computer vision [50]. It is easy for human beings to recognize the faces easily but it is a big challenge for the automated system. Appearance-based methods depend upon techniques from machine learning and statistical analysis to identify the admissible characteristics of an image [47]. Principal Component Analysis (PCA) and Independent Component Analysis (ICA) [40] and [42] are the widely used techniques for the appearance-based face recognition approach.

PCA is a method that depicts a group of sample data whereas, ICA is a method that is similar to PCA except that the division of the elements is created to be non-Gaussian.

3 | Applications of Face Recognition

Face recognition is used for two most important tasks:

Verification (1-to-1 matching) [51]-[53]: It is confirming, whether an unknown individual's identity is what he/she claims to be with the presented image. In simple words, verification means "Are you... You?"

Identification (1-to-n matching) [51]-[53]: It is confirming, whether an unknown individual's identity is what he/she claims to be with the presented image, compared against the stored data in the database. In simple words, identification is "Who Are You?"

For the above stated two purposes, there are innumerable implementations of face recognition, a few of them discussed below [40] and [45]:

- *Security [41]: email authentication, access-controlled airports, seaports, building, and computers.*
- *Surveillance [41]: a lot of CCTVs installed can be monitored to look for missing persons especially children, criminals, and offenders. These help in fraud detection and hence reduce the crime rate.*
- *Video games: labeling of the faces in the game.*
- *Healthcare: keeping patients' information confidential is an utmost priority, which can be achieved with face recognition systems. The details of the patients will only be revealed to the authorized doctors and no one else.*
- *Validate identity at the ATMs: in case of any theft at the ATMs, it is easy to look for the thief with the installed cameras.*
- *General Identity verification [41]: registration for elections, passports, national IDs, drivers' licenses, employee IDs.*
- *Attendance marking [54]: after the faces are verified and successfully recognized the attendance is marked on the server.*
- *Criminal Identification: with the increase in crimes at an alarming rate it is face-recognition systems that come to the rescue as the person may forge its identity but cannot play with its facial traits.*
- *Unlocking the phones: face recognition is a contactless feature that unlocks the phone and hence provides additional security from theft. There are many apps available that provide the user with this feature.*
- *Retail and Marketing: with the help of this technology there has been an added advantage to the shopkeepers as they get to cross verify and validate the customers' background with the data previously stored. Also, this has prevented shoplifting.*
- *Hospitality: We all know how vast the hospitality industry is. With the face recognizing systems the hotels can record the customers' fondness and can provide them with better protection. Based on their preference they can provide them with automated check-in and check-out.*

3.1 | Pros and Cons of Using Face Recognition Systems

3.1.1 | Advantages

- *Improved security: With the help of facial biometric security systems, the security system can be enhanced as every individual entering the premises will be accounted for.*
- *High accuracy: With advanced technology, facial recognition systems are highly reliable. Whether day or night, light or dark these systems work with full accuracy.*
- *Fully automated: These systems are fully automated, earlier to grant permission to a person entering the building we depended on security staff to do this job. But as technology advances, this work is taken over by these systems.*

3.1.2 | Disadvantages

Everything comes with its disadvantages and advantages, hence this is the case with these systems.

- *Camera angle: To correctly detect and recognize a person the camera angle plays an important role, they have to be in the proper alignment to capture, process, and analyze the data.*
- *Data storage: The biggest problem with these systems is that an enormous amount of data has to be stored to perform its job well.*

4 | Conclusion and Future Works

With this paper, we are able to capture the necessity of face recognition in the real-time scenario. We discussed the methods used and the vastly used applications of face-recognizing systems, and how they are proving to be a boon to human life, and why are they the most searched, discussed, and the hot topic for everyone. Given the current scenario, where the world is highly affected by the ongoing pandemic and has seen vast destruction worldwide. We are going to take this research forward and implement it in unlocking the cars without any physical contact hence, contactless car unlocking system.

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