Integratedhybrid Machine Learning Model For Basic Security And Screening In Domestic Utilization Using Facial Features: A Systematic Review

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Abstract

Face recognition is one of the important issues in object recognition and computer vision. In our day-to-day activities, a few biometric applications are available, face recognizing humans such as eye recognition, fingerprint recognition. It requires proper techniques for face detection and recognition with challenges of different facial activates, poses, conclusion again and resolution either in the frame of stationary object or video sequencing image. Face recognition and detection is the most important fields of the modern generation applications. Face recognition system uses two sub-systems face detection system and image database system. Face recognition can be of feature based and image based technology. Feature based method use the human skin color, eyes, nose, and mouth to detect and recognize the object. The project implements feature-based face recognition system which first finds any face or faces in the color image and then matches it against the database to recognize the individuals.

Keywords: Face Detection Technology

Machine Learning, Artificial Intelligence, Detection Technology, RFID,Face Recognition.

Introduction

Nowadays, cybernetics is gaining. World society is on the important of digitalization a technological and social sector of human life. One of the most popular areas of cybernetics is computer vision. Systems of video assistants that recognize images and objects are widely distributed, and social test and control systems are introduced in test mode. In this regard, the relevance of research in this area is extremely high. This paper provides an analysis of the available methods for recognizing faces in images and discusses the software implementation of one of them.

AI-based facial recognition technology is software that can instantaneously search databases of faces and compare them to one or multiple faces that are detected in a scene. Face recognition is an important part of the capability of human perception system and is a routine task for humans, while building a similar computational model of face recognition. (R. Kumar et al., 2019)

Facial features are considered as one of the important personal characteristics. This can be used in many applications, such as face recognition and age estimation. The value of these applications depends in several areas, such as security applications, law enforcement applications, and attendance systems. In addition, facial features are particularly the key usage in the finding of lost child. Present applications have achieved a high level of accuracy. This paper provides a survey of face recognition, including the age estimation, which was discussed. A comparison based on the objectives of the approaches is presented to underline the taxonomy. Ending by research conclusion on face techniques contributes to the understanding of the recognition approaches, which can be used in future. The research concluded that face techniques' performance is distinct from one data set to another. This paper contributes to

display gaps for other researchers to join this line of research. face recognition is one of the most important components for security, particularly when dealing with biometric identification and verification(Atallah et al., 2018)

It has worked on the camera which takes multi shots of human. After that, Classification has been used in application which creates the multiple human templates on system/memory space. So, the facial recognition system has been detected the human. It saved human nature in database with unique facial data.

Systems that identify people based on their biological characteristics are very attractive because they are easy to use. The human face is composed of different structures and characteristics. For this reason, in recent years, it has become one of the most widely used biometric authentication systems, given its potential in many applications and fields. Facial recognition system as an ID (identity) is already being offered to consumers outside of phones, including at airport check-ins, sports stadiums, and concerts. In addition, this system doesn't require the intervention of people to operate. The huge volume of data generated and rapid advancement in artificial intelligence techniques.

The verification process has been started by matching the human nature which is stored in the database. Through of this process, the human granted automatically.
It has been granted the person with their face detection with voice and biometric technology. It can enhance the security of facial recognition system.
The most interesting techniques are developed to face all these challenges, and thus develop reliable face recognition systems. They require high processing time, memory consumption.
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For examples: student's attendance can be marked by simply detecting their face. Students can be checked and marked by face detection process. As well as it can also be setup in govt place to enhance the security by allowing authorized persons.

Face recognition has been growing rapidly. Various techniques are being developed including local, and hybrid approaches, they also provide a face image description of human by using only a few faces of human features or the facial detection features. The main contribution of this survey is to review some well-known techniques for every approach and to give their categories. One interesting feature mentioned in the paper is about the database used for face recognition.

The face recognition step includes the features extracted from the human face to compare it with all template face databases to decide the human face identity.
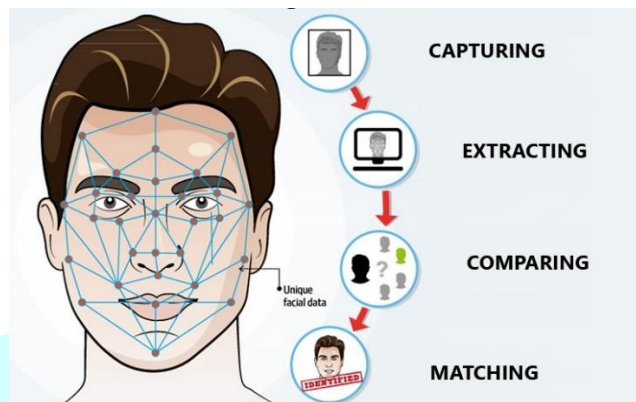
- **Face Detection**: The face recognition system begins first with the localization of the human faces in a particular image. The purpose of this step is to determine if the input image contains human faces or not. The variations of illumination and facial expression can prevent proper face detection. To facilitate the design of a further face recognition system and make it more robust, pre-processing steps are performed. Many techniques are used to detect and locate the human face image, for example, Viola–Jones detector, histogram of oriented gradient, and principal component analysis. Also, the face detection step can be used for video and image classification, object detection.

- **Feature Extraction**: The main function of this step is to extract the features of the face images detected in the detection step. This step represents a face with a set of features vector called a "signature" that describes the prominent features of the face image such as mouth, nose, and eyes with their geometry distribution.

- **Face Recognition:** This step considers the features extracted from the background during the feature extraction step and compares it with known faces stored in a specific database. There are two general applications of face recognition, one is called *identification* and another one is called *verification*.

During the identification step, a test face is compared with a set of faces aiming to find the most likely match. During the identification step, a test face is compared with a known face in the database to make the acceptance or rejection decision. Correlation filters (CFs), convolutional neural network (CNN), and it also k-nearest neighbor (K-NN) are known to effectively address this task. (Kortli et al., 2020)

Face recognition is a component of a higher-level task - identification. Also, in intelligent human-computer interfaces; in photographic equipment for automatic focusing on a human face. (Dzhangarov et al., 2020)

There are four methods of face detection:

1. Capturing
2. Extracting
3. Comparing
4. Matching

"Face recognition is the task of identifying an already detected object as a known or unknown face. Often the problem of face recognition is confused with the problem of face detection face Recognition on the other hand is to decide if the "face" is someone known, or unknown, using for this purpose a database of faces to validate this input face"

The most remarkable ability of human vision is that of face recognition. It is important for several aspects of our social life, and together with related abilities, such as estimating the expression of people with which the human interact, has played an important role during evolution. The problem of face recognition was considered in the early stages of computer vision and is now undergoing a revival after few years.

The performance of face recognition systems in controlled environments has now reached a satisfactory level, there are many challenges posed by uncontrolled environments. Some of these challenges are posed by the problems caused by variations in illumination, expression, etc. The effect of variation in the illumination conditions, which causes dramatic changes in the face appearance, is one of those challenging problems that a practical face recognition system needs to face. The variations of both global face appearance and local facial features also cause problems for automatic face detection. Therefore, the situation is even worse for a fully automatic face recognition system. In a practical application environment, the illumination variation is always coupled with other problems such as pose variation and expression variation, which increase the complexity of the automatic face recognition problem. The paper attempts here a comparative analysis of appearance-based approaches to face recognition. The famous face recognition techniques are appearance based; Feature extraction from original database is an important step in pattern recognition tasks and it poses the input data onto feature space. Feature extraction is to map the original data on a discriminative feature space, in which the samples from different classes are clearly separated. Several face recognition approaches have been proposed in the past years. The proposed paper categorizes the appearance-based approach into two main categories. We call the approaches in the first category as "Holistic" approaches. These methods are use in whole face region recognition system. One of the most widely used representations of the face region is Eigen pictures, which are based on principal component analysis. The other category contains "Hybrid" approaches, just as the human perception system uses both local features and the whole face region to recognize a face, a machine recognition system should use both. One can argue that these methods could potentially offer the better of the two types of methods. The review presented in this paper is more extensive than previous reviews and covers more recent techniques in both groups. In this paper, comparison is done over different face recognition systems which might be good for one technique while a little erroneous for the other one.

The following methods are used to detect the faces:

1. Feature Based.
2. Image Based.
3. Geometry Based.
4. Neural Network.
5. Statical Approach.

1. Feature Based Approach.

Technique: Feature-based methods try to find invariant features of faces for detection. The underlying idea is based on the observations that human vision can effortlessly detect faces in different poses and lighting conditions, so there must be properties or features which are consistent despite those variabilities. A wide range of methods has been proposed to detect facial features to then infer the presence of a face.

Examples: Edge detectors commonly extract facial features such as eyes, nose, mouth, eyebrows, skin color, and hairline. Based on the extracted features, statistical models were built to describe their relationships and verify a face's presence in an image.

Advantages: Easy to implement, the traditional approach.

Disadvantages: A major problem of feature-based algorithms is that the image features can be severely corrupted due to illumination, noise, and occlusion. Also, feature boundaries can be weakened for faces, and shadows can cause strong edges, which together render perceptual grouping algorithms useless.

2. Image Based Approach.

Technique: Image-based methods try to learn templates from examples in images. Hence, appearance-based methods rely on machine learning and statistical analysis techniques to find the relevant characteristics of "face" and "no-face" images. The learned characteristics are in the form of distribution models or discriminant functions that is applied for face detection tasks.

Examples: Image-based approaches include neural networks (CNN), support vector machines (SVM), or Ad boost.

Advantages: Good performance, higher efficiency.

Disadvantages: Difficult to implement. Dimensionality reduction is usually required for the sake of computation efficiency and detection efficacy. This means reducing the dimensionality of the feature space with consideration by obtaining a set of principal features, retaining meaningful properties of the original data.

Literature Review

Face detection is a computer technology that determines the location and size of a human face in a digital image. Face detection has been a standout amongst topics in the computer vision literature. Face detection is the step stone to all facial analysis algorithms, including the face alignment, face modelling, face relighting, face recognition, face verification/authentication, head pose tracking, facial expression tracking, recognition, gender & age recognition, and many more. computers can understand face clearly, after that they begin to truly understand people's thoughts and intentions. The face recognition system considered one of the most significant applications in image processing system. This form may deliver great challenges in computer vision and pattern recognition due to many reasons such as diversities in facial expression problems, illumination effects and image complexity.

Face recognition is an efficient technique and one of the most preferred biometric techniques for the identification and verification of individuals objects as compared to voice, fingerprint, iris, retina eye scan, gait, ear, and hand geometry. A major reason why it remains fast-growing research lies in its application in unconstrained environments, where most existing techniques do not perform optimally.(Oloyede et al., 2020)

An input camera device is required to take the multiple shots of the object/person. As for the algorithm, Cascade classification is used for creating the multiple templates of the facial and detects facial features. A database is used for storing the templates along with student's roll number which acts as unique ID. Throughout the verification process, the camera detects the facial features and tries to match against the templates which are already stored in the database; if found then it runs through the attendance management system process and marks the attendance for a particular student otherwise absent will be marked for not present students.

Challenges in face detection, are the reasons which reduce the accuracy of face detection. These challenges are complex background.

- Odd expressions Human face in an image may have odd expressions unlike normal, which is challenge for face detection. Face occlusion Face occlusion is hiding face by any object. It may be glasses, scarf, hand, hairs, hats, and any other object etc. It also reduces the face detection rate.
- Illuminations Lighting effects may not be uniform in the image. Some part of the image may have very high illumination and other may have very low illumination.
- Complex background Complex background means a lot of objects presents in the image, which reduces the accuracy and rate of face detection.
- Less resolution of image may be very poor, which is also challenging for face detection. • Skin color Skin-color changes with geographical locations. Skin color of Chinese is different from African and skin-color of African is different from American and so on. Changing skin-color is also challenging for face detection.

Face Recognition Phase

It's utilized to achieve automatic authentication and identification of the individuals. Each face recognition system maintains a face in data base that stores information about all input / stored face feature for everyone several images should be taken and then extracted features stored in this dedicated Data base.
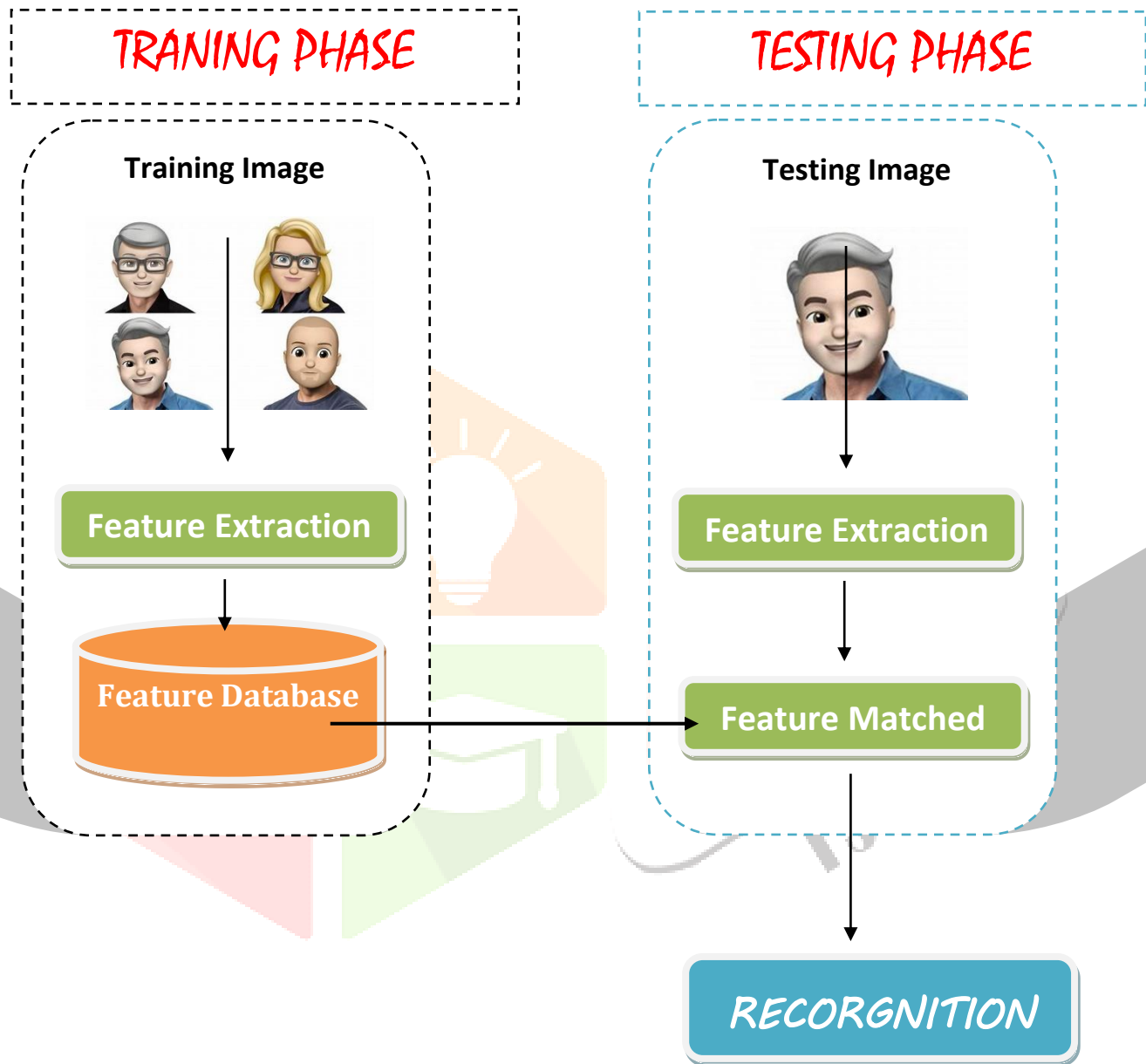
APPEARANCE BASED APPROACH

Appearance based face recognition techniques have received significant attention from a wide range of research areas such as biometrics, pattern recognition, computer vision and machine mining. Although humans can recognize faces easily, building automated face recognition systems remains a great challenge in computer-based automated recognition research. To have a clear and high-level categorization, instead follow a guideline suggested by the psychological study of how humans use holistic and local features. Specifically, the proposed papers have the following categorization: Holistic approaches and Hybrid approaches.(Beham & Roomi, 2012)

Currently, data generated by smart devices connected through the Internet is increasing relentlessly. An effective and efficient paradigm is needed to deal with the bulk amount of data produced by the Internet of Things (IoT). Deep learning and edge computing are the emerging technologies, which are used for efficient processing of huge amount of data with distinct accuracy. In this world of advanced information systems, one of the major issues is authentication. Several techniques have been employed to solve this problem. Face recognition is considered as one of the most reliable solutions. Usually, for face recognition, scale-invariant feature transforms (SIFT) and speeded up robust features (SURF) have been used by the research community. This paper proposes an algorithm for face detection and recognition based on convolution neural networks (CNN), which outperform the traditional techniques. To validate the efficiency of the proposed algorithm, a smart classroom for the student's attendance using face recognition has been proposed. The face recognition system is trained on publicly available labeled faces in the wild (LFW) dataset. The system can detect approximately 35 faces and recognizes 30 out of them from the single image of 40 students. The proposed system achieved 97.9% accuracy on the testing data. Moreover, generated data by smart classrooms is computed and transmitted through an IoT-based architecture using edge computing. A comparative performance study shows that our architecture outperforms in terms of data latency and real-time response.

HUMAN FACE RECOGNITION

The human face is an important entity which plays a crucial role in our daily social interaction, like conveying individual's identity. Face recognition is a biometric technology that extracts the facial features mathematically and then stores those features as a face print to identify the individual. Biometric face recognition technology gained a lot of attention during the past few years due to its wide range of applicability in both law enforcement and other civilian areas, institutes, and organizations. Face recognition technology has a slight edge on other biometric systems like fingerprint, palm-print, and iris due to its non-contact process. Face recognition system is also able to recognize the person from a distance without touching or any interaction with the person. Moreover, the face recognition system also helps in crime deterrent purpose because the captured image can be stored in a repository and later can be helpful in many ways like to identify a person. Currently, face recognition applications are deployed in social media websites like Facebook, in the entrance of Airports, Railways Stations, Bus Stop, highly secured areas, advertisement, and health care. The purpose of these applications is to minimize criminal activities, fake authentication, tracking addictive gamblers in casinos, whereas Facebook is using face recognition system for automatic tagging purpose. For face recognition purpose, there is a need for large data sets and complex features to uniquely identify the different subjects by manipulating different obstacles like illumination, pose and aging. During the recent few years, a good improvement has been made in facial recognition systems. In comparison to the last decade, one can observe an enormous development in the world of face recognition. Currently, most of the facial recognition systems perform well with limited faces in the frame. Moreover, these methodologies have been tested under controlled lighting conditions, proper face poses and nonblurry images. Machine learning on edge computing nodes is also gaining popularity and likely to rise even more with the passage of time. Edge computing is defined as the technology that enable the data processing at the edges of the network. The edge computing is helpful in many ways such as to reduce the traffic, cloud computing, and storage resources over the network. It is also helpful in reducing the response time and data latency and making the data transmission more safe and secure. The concept of smart homes and buildings equipped with smart devices has becomes popular now days. These devices can automate the human activities. Face recognition has also its implications in making the classrooms smart. In currently available smart architecture deployed at homes, cities and some specific buildings, the data produced by the nodes are passed to the cloud for further processing. The amount of data produced at the edge of the network is very large, so there is a need to process the data at the edges of the network to reduce data latency. Face recognition requires a large amount of computation and processing power with the large amount of database with whom the encodings of the input image is compared. With the availability of cheap bandwidth and fast internet speed, the computational data of the face recognizer is transfer to the edge device to get the faster results. The accuracy of the recognition task has remarkably increased due to the availability of high computational power, required for the deep learning algorithms. To achieve better results, proposed algorithm utilizes the Convolution Neural Network, which is a deep learning approach and state-of the-art in computer vision. The proposed methodology can recognize the people even when frame has multiple faces. This system can recognize the people from different positions and under different lighting conditions, as light does not have much effect on the system. Moreover, to improve the data

latency and response time, edge computing has been utilized for implementing the smart classrooms in real time. Below are the major contributions of this paper:

- Propose a deep unified model for Face Recognition based on Faster Region Convolution Neural Network. Design a group-based face attendance system based on the proposed deep unified model.
- The proposed model can recognize 30 faces out of the 35 detected faces. Achieve an accuracy of 97.9% by implementing the proposed algorithm under different conditions.
- Edge Computing have been utilized for processing the data at the edges of the nodes to reduce the data latency and increase the real time response(Khan et al., 2019)

Feature Extraction Phase

This stage will receive the detected face image as an input. Through using feature extraction algorithm, all face characteristics will be extracted effectively from the face region such as the distance among eye, lip, and nose. The main purpose of feature extraction process is to perform specific functionalities including packing of information, cleaning of noise, and o salience. After that, the obtained information is transferred into a vector for the subsequent process and use like comparison of obtained feature with stored data.

Face Recognition Phase

- Document control and access control can be imposed to document access with face identification system. Photography some recent facial features like nose, eyes, mouth, skin color etc. can be extracted from image.
- Human computer interaction system it is design and use of computer technology. Focusing particularly on the interface between users and computers. Biometric attendance it is system of taking attendance of people by their fingerprints or face etc.
- A facial recognition system is a process of identifying or verifying a person from a digital image or a video frame. One of the ways to do this is by comparing selected facial features from the image and facial database. It is typically used in security systems.
- Marketing face detection is gaining the interest of marketers. A webcam can be integrated into a television and detect any face that walks by. The system then calculates the race, gender, and age range of the face. Once information is collected a series of advertisements can be played that is specific towards the detected race/gender/age.

Keywords: Face Detection, Image Processing, Distinctive Characteristic Location, Template Creation & Matching.(Siddiqui, 2020)

Face Detection Techniques

Face detection is a computer technology that determines the location and size of a human face in the digital image. The facial features are detected and any other objects like trees, buildings and bodies are ignored from the digital image. It can be regarded as a specific case of object-class detection, where the task is finding the location and sizes of all objects in an image that belongs to a given class. Face detection can be seen as a more general case of face localization. In face localization, the task is to identify the locations and sizes of a known number of faces (usually one). Basically, there are two types of approaches to detect facial part in the given digital image feature based and image-based approach. Feature based approach tries to extract features of the image and match it against the knowledge of the facial features. While image-based approach tries to get the best match between training and testing images.

Discussion

a. Various fields

Face detection also called facial detection is an artificial intelligence-based computer technology used to find and identify human face in digital image. Face detection technology can be applied to various fields including:

- Security
- Biometrics
- Education

b. Reviewing the techniques /methods used (Features/ ML models/ techniques

The methods used in face detection can be knowledge-based, feature-based, template matching or   appearance-based. Each has advantages and disadvantages:

- Knowledge-based, or rule-based methods, describe a face based on rules. The challenge of this approach is the difficulty of coming up with well-defined rules.

- Feature invariant methods -- which use features such as a person's eyes or nose to detect a face -- can be negatively affected by noise and light.

- Template-matching methods are based on comparing images with standard face patterns or features that have been stored previously and correlating the two to detect a face. Unfortunately, these methods do not address variations in pose, scale and shape.

- Appearance-based methods employ statistical analysis and machine learning to find the relevant characteristics of face images. This method, also used in feature extraction for face recognition, is divided into sub-methods.

Some of the more specific techniques used in face detection include:

- Removing the background. For example, if an image has a plain, mono-color background or a pre-defined, static background, then removing the background can help reveal the face boundaries.

- In color images, sometimes skin color can be used to find faces; however, this may not work with all complexions.

- Using motion to find faces is another option. In real-time video, a face is almost always moving, so users of this method must calculate the moving area. One drawback of this method is the risk of confusion with other objects moving in the background.

- A combination of the strategies listed above can provide a comprehensive face detection method.

c.   Accuracy

Facial recognition is pretty accurate, **99.97%** accurate to be exact. And as stated before, the facial recognition algorithm only gets better as it compiles a larger list of faces to compare others against. The false fail rates tend to be low, less than one percent and are being worked on daily.

d.   Merits /demerits

As a key element in facial imaging applications, such as facial recognition and face analysis face detection creates various merits for users. including:

- Improved security
  Face detection improves survellienadedfforsds and helps track down criminals and terrorists' personal security is also enhanced since there is nothing for hackers to steal or change such as passwords.

- Easy to integrate.
  Face detection and facial recognition technology is easy to integrate and most solutions are compatible with the majority of security software

- Automated identification
  In the past identification was manually performed by a person this was inefficient and frequently inaccurate. Face detection allows the identification process to be automated this saving time and increasing accuracy.

Demerits

- Massive data storage burden
- Detection is vulnerable
- Potential breach of privacy

e.   Requirement of such systems – justification

Face detection is the step stone to all facial analysis algorithms, including the face alignment, face modelling, face relighting, face recognition, face verification/authentication, head pose tracking, facial expression tracking, recognition, gender & age recognition, and many more. A database is used for storing the templates along with student's roll number which acts as unique ID.

Conclusion

In recent years face detection has achieved considerable attention from researchers in biometrics, pattern recognition, and computer vision groups. There is countless security, and forensic applications requiring the use of face recognition technologies. As you can see, face detection system is very important in our day-to-day life. It is exciting to see face detection techniques be increasingly used in real-world applications and products. In this article, we have presented a survey of face detection techniques Applications and challenges of face detection also discussed which motivated us to do research in face detection. This appears as a trivial task for human beings, but it is a very challenging task for computers, and has been one of the top studied research topics in the past few decades. The recent development in machine learning and technologies: make it possible to generate an intelligence system based on statical learning

methodologies as a facial recognition. Among the entire sorts of biometric, face detection and recognition system are the most accurate. The most straightforward future direction is to further improve the face detection in presence of some problems like face occlusion and non-uniform illumination. Current research focuses on field of face detection and recognition is the detection of faces in presence of occlusion and non-uniform illumination. If it happens, it will help a lot to face recognition, face expression recognition etc. Currently many companies providing facial biometric in mobile phone for purpose of access. In future it will be used for payments, security, healthcare, advertising, criminal identification etc. Many research place considerable efforts in this area to overcome the limitations of Face Recognition using Artificial Neural Network approach, many issues are still required to be solved. (A. Kumar et al., 2019)

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methodologies. From this Literatures: It is very important to remove background information. Removing irrelevant information, such as noise etc. Feature based analysis is one of the predominant methodologies that most of the Detection Algorithms use in one way or another. Hence, efficient feature selection is very crucial. We must choose at-least two features for face identification. Because depending only on one feature might result in erroneous detection. Varied Facial Expression and poses makes face detection more complicated. Lightning conditions greatly affects face detection. Computations need to be fast and should require less main memory as majority of application are of real time in nature. When going through the cascade like methodology, re-computation of an already computed face must be avoided. It is very essential for a methodology to define its definition of face and successful face detection. Face recognition is a challenging problem in the field of computer vision, which has received a great deal of attention over the past years because of its several applications in various domains (Pandya, 2016)

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