Facial recognition

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Abstract: -

- Face recognition technology is a biometric technology, which is based on the identification of facial features of a person.

- People collect the face images, and the recognition equipment automatically processes the images.

- Face recognition has become the future development direction and has many potential application prospects.

The Process of Automatic Face Recognition consists of: -

1. Face Detection.

2. Face Alignment.

3. Feature Extraction.

4. Face Recognition.

Face Detection

Definition:

 Face detection -- also called facial detection -- is an artificial intelligence (AI) based computer technology used to find and identify human faces in digital images. Face detection technology can be applied to various fields -- including security, biometrics, law enforcement, entertainment, and personal safety -- to provide surveillance and tracking of people in real time.

Applications:

1. Facial motion capture

2. Facial recognition

3.Photography

4.Marketing

5.Lip Reading

6.Emotional Inference

Difference between face detection and face recognition:

Face detection is a broader term than face recognition. Face detection just means that a system can identify that there is a human face present in an image or video. ... Face recognition can confirm identity. It is therefore used to control access to sensitive areas.

Face detection task:

Face recognition is the problem of identifying and verifying people in a photograph by their face. It is a task that is trivially performed by humans, even under varying light and when faces are changed by age or obstructed with accessories and facial hair

Face alignment

Definition and usage:

The face alignment is one of the important stages of the face recognition. Moreover, face alignment is also used for other face processing applications, such as face modeling and synthesis. Its objective is to localize the feature points on face images such as the contour points of eye, nose, mouth, and face (illustrated in Figure 1).
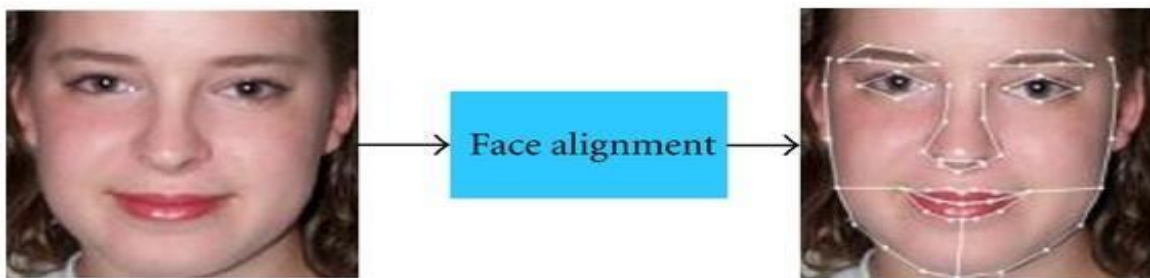

Fig 1)

Most known methods:

Two popular face alignment methods are active shape model (ASM) and active appearance model (AAM) proposed by Cootes. The two methods use a statistical model to parameterize a face shape with PCA method. However, their feature model and optimization are different. ASM algorithm has a 2-stage loop: in the first stage, given the initial labels, searching for a new position for every label point in its local region which best fits the corresponding local 1D profile texture model; in the second stage, updating the shape parameters which best fit these new label positions.

Feature Extraction

Definition:

Facial feature extraction is the process of extracting face component features like eyes, nose, mouth, etc. from human face image. Facial feature extraction is very much important for the initialization of processing techniques like face tracking, facial expression recognition or face recognition.

Most known techniques: -

1. Geometric feature-based method group: the features are extracted by using relative positions and sizes of the important components face such as eyes, nose, mouth, and other vital component of face. The advantage of these methods is the concentration on important components of face such as eyes, nose, and mouth but the disadvantage is not to remain face global structure.

2. Template-based method Group: based on a template function and appropriate energy function, this method group will extract the feature of important components of face such as eyes and mouth, or face shape. An image region is the best appropriateness with template (eyes, mouth, etc.) which will minimize the energy. Advantages of this group method are using template and determining parameter for important components of face, but disadvantage is not to reflect face global structure.

3. Color segmentation-based method group: this group method is based on skin's color to isolate the face

4. Appearance-based method group: The goal of this method group is using linear transformation and statistical methods to find the basic vectors to represent the face.

Face recognition tasks

The task of face recognition is broad and can be tailored to the specific needs of a prediction problem.

For example, in the 1995 paper titled "*Human and machine recognition of faces: A survey,*" the authors describe three face recognition tasks:

Face Matching: Find the best match for a given face.

Face Similarity: Find faces that are most like a given face.

Face Transformation: Generate new faces that are like a given face.

They summarize these three separate tasks as follows:

Matching requires that the candidate matching face image be in some set of face images selected by the system. Similarity detection requires in addition to matching that image of faces be found which are like a recalled face this requires that the similarity measure used by the recognition system closely match the similarity measures used by humans Transformation applications require that new images created by the system be like human recollections of a face.

— Human and machine recognition of faces: A survey, 1995.

The 2011 book on face recognition titled "*Handbook of Face Recognition*" describes two main modes for face recognition, as:

1. Face Verification. A one-to-one mapping of a given face against a known identity (e.g., is this the person?).
2. Face Identification. A one-to-many mapping for a given face against a database of known faces (e.g., who is this person?).

Example of Applications to face recognition

Social media

Founded in 2013, Looksery went on to raise money for its face modification app on Kickstarter. After successful crowdfunding, Looksery launched in October 2014. The application allows video chat with others through a special filter for faces that modifies the look of users. Image augmenting applications already on the market, such as Facetune and Perfect365, were limited to static images, whereas Looksery allowed augmented reality to live videos. In late 2015 Snap Chat purchased Looksery, which would then become its landmark lens's function. Snapchat filter applications use face detection technology and on the basis of the facial features identified in an image a 3D mesh mask is layered over the face.

ID verification

The emerging use of facial recognition is in the use of ID verification services. Many companies and others are working in the market now to provide these services to banks, ICOs, and other e-businesses. Face recognition has been leveraged as a form of biometric authentication for various computing platforms and devices; Android 4.0 "Ice Cream Sandwich" added facial recognition using a smartphone's front camera as a means of unlocking devices, while Microsoft introduced face recognition login to its Xbox 360 video game console through its Kinect accessory, as well as Windows 10 via its "Windows Hello" platform (which requires an infrared-illuminated camera).In 2017 Apple's iPhone X smartphone introduced facial recognition to the product line with its "Face ID" platform, which uses an infrared illumination system.

Advantages and disadvantages

Compared to other biometric systems

In 2006, the performance of the latest face recognition algorithms was evaluated in the Face Recognition Grand Challenge (FRGC). High-resolution face images, 3-D face scans, and iris images were used in the tests. The results indicated that the new algorithms are 10 times more accurate than the face recognition algorithms of 2002 and 100 times more accurate than those of 1995. Some of the algorithms were able to outperform human participants in recognizing faces and could uniquely identify identical twins.

One key advantage of a facial recognition system that it can perform mass identification as it does not require the cooperation of the test subject to work. Professionally designed systems installed in airports, multiplexes, and other public places can identify individuals among the crowd, without passers-by even being aware of the system. However, as compared to other biometric techniques, face recognition may not be most reliable and efficient. Quality measures are particularly important in facial recognition systems as large degrees of variations are possible in face images. Factors such as illumination, expression, pose and noise during face capture can affect the performance of facial recognition systems.Among all biometric systems, facial recognition has the highest false acceptance and rejection rates, thus questions have been raised on the effectiveness of face recognition software in cases of railway and airport security

Weaknesses

Ralph Gross, a researcher at the Carnegie Mellon Robotics Institute in 2008, describes one obstacle related to the viewing angle of the face: "Face recognition has been getting pretty good at full frontal faces and 20 degrees off, but as soon as you go towards profile, there've been problems." Besides the pose variations, low-resolution face images are also extremely hard to recognize. This is one of the main obstacles of face recognition in surveillance systems.

Face recognition is less effective if facial expressions vary. A big smile can render the system less effective. For instance: Canada, in 2009, allowed only neutral facial expressions in passport photos.

There is also inconstancy in the datasets used by researchers. Researchers may use anywhere from several subjects to scores of subjects and a few hundred images to thousands of images. It is important for researchers to make available the datasets they used to each other, or have at least a standard dataset. Facial recognition systems have been criticized for upholding and judging based on a binary gender assumption.

When classifying the faces of cisgender individuals into male or female, these systems are often exactly accurate, however were typically confused or unable to determine the gender identity of transgender and non-binary people. Gender norms are being upheld by these systems, so much so that even when shown a photo of a cisgender male with long hair, algorithms were split between following the gender norm of males having short hair, and the masculine facial features and became confused. This accidental misgendering of people can be very harmful for those who do not identify with their sex assigned at birth, by disregarding and invalidating their gender identity. This is also harmful for people who do not ascribe to traditional and outdated gender norms, because it invalidates their gender expression, regardless of their gender identity.

Controversies

Privacy violations

Civil rights organizations and privacy campaigners such as the Electronic Frontier Foundation, Big Brother Watch, and the ACLU express concern that privacy is being compromised using surveillance technologies. Face recognition can be used not just to identify an individual, but also to unearth other personal data associated with an individual – such as other photos featuring the individual, blog posts, social media profiles, Internet behavior, and travel patterns. Concerns have been raised over who would have access to the knowledge of one's whereabouts and people with them at any given time. Moreover, individuals have limited ability to avoid or thwart face recognition tracking unless they hide their faces. This fundamentally changes the dynamic of day-today privacy by enabling any marketer, government agency, or random stranger to secretly collect the identities and associated personal information of any individual captured by the face recognition system. Consumers may not understand or be aware of what their data is being used for, which denies them the ability to consent to how their personal information gets shared

In July 2015, the United States Government Accountability Office conducted a Report to the Ranking Member, Subcommittee on Privacy, Technology and the Law, Committee on the Judiciary, U.S. Senate. The report discussed facial recognition technology's commercial uses, privacy issues, and the applicable federal law. It states that previously, issues concerning facial recognition technology were discussed and represent the need for updating the privacy laws of the United States so that federal law continually matches the impact of advanced technologies. The report noted that some industry, government, and private organizations were in the process of developing, or have developed, "voluntary privacy guidelines". These guidelines varied between the stakeholders, but their overall aim was to gain consent and inform citizens of the intended use of facial recognition technology. According to the report the voluntary privacy guidelines helped to counteract the privacy concerns that arise when citizens are unaware of how their personal data gets use.

In 2016 Russian company NtechLab caused a privacy scandal in the international media when it launched the FindFace face recognition system with the promise

that Russian users could take photos of strangers in the street and link them to a social media profile on the social media platform Vkontakte (VT). In December 2017, Facebook rolled out a new feature that notifies a user when someone uploads a photo that includes what Facebook thinks is their face, even if they are not tagged. Facebook has attempted to frame the new functionality in a positive light, amidst prior backlashes. Facebook's head of privacy, Rob Sherman, addressed this new feature as one that gives people more control over their photos online. "We've thought about this as a really empowering feature," he says. "There may be photos that exist that you don't know about."Facebook's DeepFace has become the subject of several class action lawsuits under the Biometric Information Privacy Act, with claims alleging that Facebook is collecting and storing face recognition data of its users without obtaining informed consent, in direct violation of the 2008 Biometric Information Privacy Act (BIPA). The most recent case was dismissed in January 2016 because the court lacked authority.[144] In the US, surveillance companies such as Clearview AI are relying on the First Amendment to the United States Constitution to data scrape user accounts on social media platforms for data that can be used in the development of facial recognition systems.

In 2019 the Financial Times first reported that facial recognition software was in use in the King's Cross area of London. The development around London's King's Cross mainline station includes shops, offices, Google's UK HQ, and part of St Martin's College. According to the UK Information Commissioner's Office: "Scanning people's faces as they lawfully go about their daily lives, in order to identify them, is a potential threat to privacy that should concern us all." The UK Information Commissioner Elizabeth Denham launched an investigation into the use of the King's Cross facial recognition system, operated by the company Argent. In September 2019 it was announced by Argent that facial recognition software would no longer be used at King's Cross. Argent claimed that the software had been deployed between May 2016 and March 2018 on two cameras covering a pedestrian street running through the center of the development.In October 2019 a report by the deputy London mayor Sophie Linden revealed that in a secret deal the Metropolitan Police had passed photos of seven people to Argent for use in their King's cross facial recognition system.

Automated Facial Recognition was trialed by the South Wales Police on multiple occasions between 2017 and 2019. The use of the technology was challenged in

court by a private individual, Edward Bridges, with support from the charity Liberty (case known as R (Bridges) v Chief Constable South Wales Police). The case was heard in the Court of Appeal and a judgement was given in August 2020.The case argued that the use of Facial Recognition was a privacy violation on the basis that there was insufficient legal framework or proportionality in the use of Facial Recognition and that its use was in violation of the Data Protection Acts 1998 and 2018. The case was decided in favor of Bridges and did not award damages. The case was settled via a declaration of wrongdoing. In response to the case, the British Government has repeatedly attempted to pass a Bill regulating the use of Facial Recognition in public spaces. The proposed Bills have attempted to appoint a commissioner with the ability to regulate Facial Recognition use by Government Services in an analogous manner to the Commissioner for CCTV. Such a Bill has yet to come into force [correct as of September 2021.

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