Biometric Access Control

FACE RECOGNITION

Face recognition is one of the most flexible methods of biometric identification. It is an application that helps identify a person or verify a person from a digital image or a video frame from a video source. **One of the ways to do this is by comparing selected facial features from the image and a facial database.**

Face recognition systems analyze specific features like the distance between the eyes, width of the nose, position of cheekbones, jaw line, chin and so forth. These numerical quantities are then combined in a single code that uniquely identifies each person.

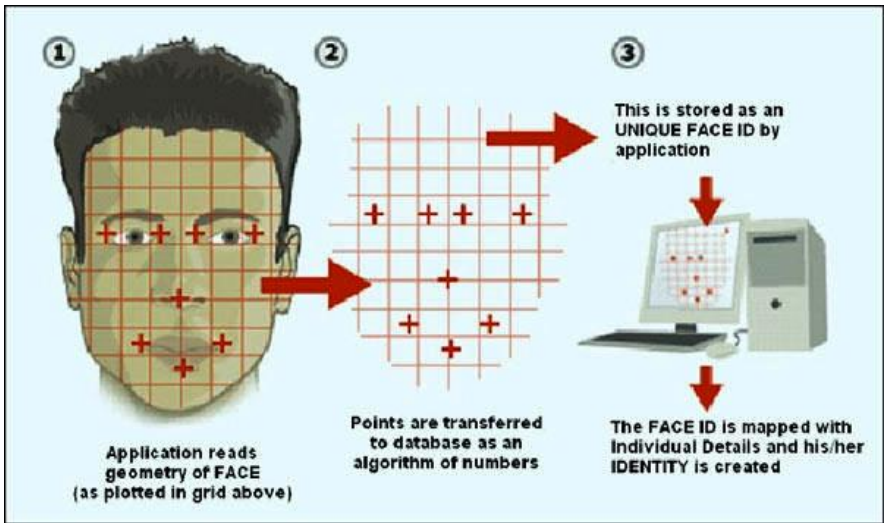
Face recognition technology is the fastest and least intrusive biometric technology. It only needs the most obvious individual identifier – the human face.
Instead of requiring people to place their hand on a reader or precisely position their eye in front of a scanner, **face recognition systems unobtrusively take pictures of people's faces as they enter a defined area.** There is no intrusion or delay, and in most cases the subjects are entirely unaware of the process. They do not feel "under surveillance" or that their privacy has been invaded.

How facial recognition works

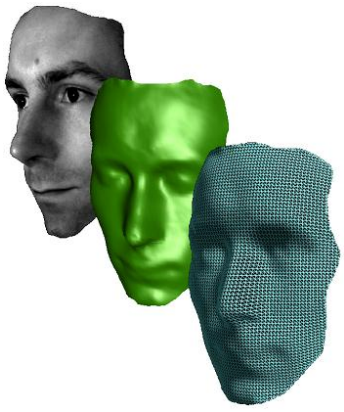
Every face has numerous distinguishable nodal points (landmarks), the different peaks and valleys that make up facial features. Each human face has approximately 80 nodal points. Some of these measured by the software are:

- **Distance between the eyes**
- **Width of the nose**
- **Depth of the eye sockets**
- **The shape of the cheekbones**

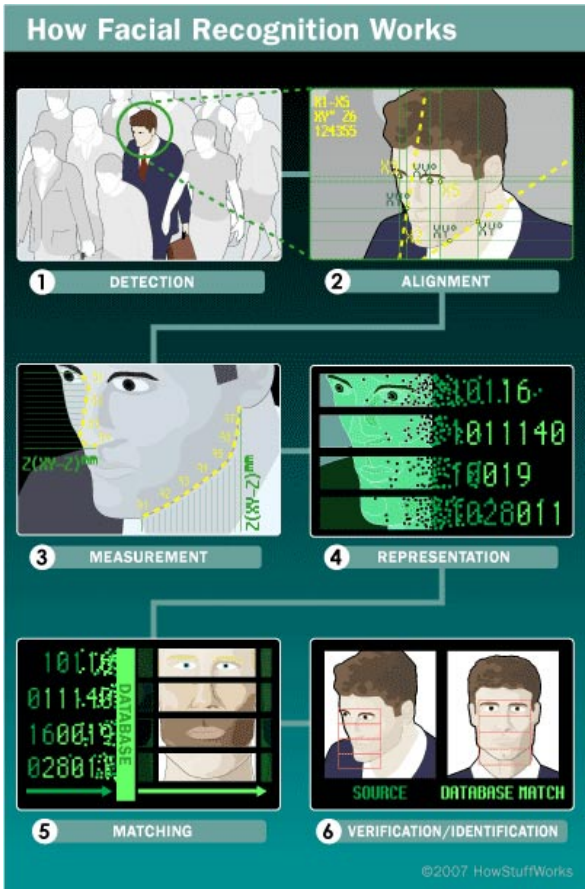
- **The length of the jaw line**



These nodal points are measured creating a numerical code, called a **face print**, representing the face in the database.
In the past, facial recognition software has relied on a 2D image to compare or identify another 2D image from the database. To be effective and accurate, the image captured needed to be of a face that was looking almost directly at the camera, with little variance of light or facial expression from the image in the database. This created a problem. In most instances the images were not taken in a controlled environment. Even the smallest changes in light or orientation could reduce the effectiveness of the system, so they couldn't be matched to any face in the database, leading to a high rate of failure.
3D facial recognition has made face matching and recognition more accurate. This software uses a 3D model to provide more accuracy. 3D facial recognition uses distinctive features of the face where rigid tissue and bone is most apparent, such as the curves of the eye socket, nose and chin, to identify the subject. These areas are all unique and don't change over time.



Using depth and an axis of measurement that is not affected by lighting, **3D facial recognition can even be used in the dark**. It has the ability to recognize a subject at different view angles with the potential to recognize up to 90 degrees (a face in profile).
Using the 3D software, the system goes through a series of steps to verify the identity of an individual.



Detection

Acquiring an image can be accomplished by digitally scanning an existing photograph (2D) or by using a video image to acquire a live picture of a subject (3D).

Alignment

Once it detects a face, the system determines the head's position, size and pose. The subject has the potential to be recognized up to 90 degrees, while with 2D, the head must be turned at least 35 degrees toward the camera.

Measurement

The system then measures the curves of the face on a sub-millimetre scale and creates a template.

Representation

The system translates the template into a unique code. This coding gives each template a set of numbers to represent the features on a subject's face.

Matching

If the image is 3D and the database contains 3D images, then matching will take place without any changes being made to the image. However, there is a challenge currently facing databases that are still in 2D images. 3D provides a live, moving variable subject being compared to a flat, stable image. New technology is addressing this challenge. When a 3D image is taken, different points (usually three) are identified. For example, the outside of the eye, the inside of the eye and the tip of the nose will be pulled out and measured. Once those measurements are in place, an algorithm is applied to the image to convert it to a 2D image. After conversion, the software compares the image with the 2D images in the database to find a potential match.

Verification or Identification

In verification, an image is matched to only one image in the database (1:1). For example, an image taken of a subject may be matched to an image in the database to verify whether the subject is who he says he is. If identification is the goal, then the image is compared to all images in the database

resulting in a score for each potential match (1:N). In this instance, one needs to take an image and compare it to a database of 'mug shots' to identify who the subject is.

Applications

Face recognition is ideal for high traffic areas that are open to the general public, such as:

- Airports and railway stations
- Corporations
- Cash points
- Stadiums
- Public transportation
- Financial institutions
- Government offices
- Businesses of all kinds
- A potential tool for averting terrorist crimes

Limitations

Image quality affects how well facial-recognition algorithms work. The image quality of scanning video is quite low compared with that of a digital camera.
Image size – Pixels captured matter. An already small image size, coupled with a target distant from the camera, means that the detected face is only 100 to 200 pixels on a side. Further, having to scan an image for varying face sizes is a processor-intensive activity.
Face angle - The relative angle of the target's face influences the recognition score profoundly. When a face is enrolled in the recognition software, usually multiple angles are used (profile, frontal and 45-degree are common). The more direct the image (both enrolled and probe image) and the higher its resolution, the higher the score of any resulting matches.
Processing and storage - High-definition video requires a significant amounts of disk space. Processing every frame of video is an enormous undertaking, so usually only a fraction (10 percent to 25 percent) is actually run through a recognition system. To minimize total processing time, agencies can use clusters of computers. However, adding computers involves considerable data transfer over a network, which can be bound by input-output restrictions, further limiting processing speed.

Summary

One of the strongest positive aspects of facial recognition is that it is non-intrusive. Verification or identification can be accomplished from two feet away or more, and without requiring the user to wait for long periods of time or do anything more than look at the camera.
Face recognition is also very difficult to fool. It works by comparing facial landmarks - specific proportions and angles of defined facial features - which cannot easily be concealed by beards, eyeglasses or makeup.

As with any developing technology, the incredible potential of facial recognition has limitations, but manufacturers are striving to enhance the usability and accuracy of the systems.
