# *Biometric authentication techniques*

## A guide

*THE VOICE OF THE* **PROFESSIONAL SECURITY INDUSTRY**

bsia
british security industry association

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# Introduction

Biometrics is the name given to various methods used to recognize humans based on individual physical properties or behavioural traits. Whilst behaviour analysis might be used for surveillance purposes, when considered to identify individuals for control of systems or granting permission, the physical methods of identification are currently more appropriate. For security systems, biometrics can be used to allow restricted access to control of equipment. It can frequently permit users to enter all or part of a building via an Access Control system.

# 1. Scope

This guide provides an overview of the currently available biometric technologies typically used within an Access Control or Integrated Security System.

# 2. Terms, Definitions, and abbreviations

## 2.1. Definitions and abbreviations

### 2.1.1. Enrolment:

Enrolment is the process whereby the user's biometric template is captured and stored within the system for comparison later during normal operation.

### 2.1.2. Templates:

A template is a data representation of the biometric being measured and is stored as a series of 1s and 0s.  A template is a data representation of the measured biometric and stored as a series of 1s and 0s.s. The template can be stored in several places depending on the design of the system and the customer's requirements. Biometric templates vary in size from a few hundred bytes to a few kilobytes depending on the characteristics being captured. It is not possible to identify an individual using the limited data stored in the template. For multiple biometric reading devices, templates are often combined using a suitable algorithm such that each template cannot be recovered.

### 2.1.3. Matching:

To confirm the identity, the biometric of the characteristic captured by the device is matched against a stored template that was taken when the user enrolled on the system. There are two methods by which biometric data is confirmed against a pre-enrolled stored template, verification, and identification.

### 2.1.4. Verification:

"One to One" (1:1) technology is where the user's biometric sample is compared to a single template stored by the biometric system. The term used to describe this method is verification because the user is verifying a known template. The user identifies themselves to the system (e.g. via a keypad, smartcard, etc.) and then a biometric feature is scanned. This method is usually quick because the biometric system does not need to search through all records stored to find the user's template.

### 2.1.5. Identification:

"One to Many" (1: N) technology is where the recorded biometric feature is compared to all biometric data saved in a system. This method is referred to as identification due to the user being unknown to the system before providing a biometric sample. The identification is successful if there is a match, and the corresponding username or user ID may be processed. The speed of identification can deteriorate proportionally with the greater number of users enrolled.

### 2.1.6. FRR:

False Reject Rate is the percentage of instances where a false rejection of the biometric occurs.

### 2.1.7. FAR:

False Acceptance Rate is the percentage of instances where a false acceptance of a biometric occurs.

## 3. Authentication

### 3.1.1. Single Factor:

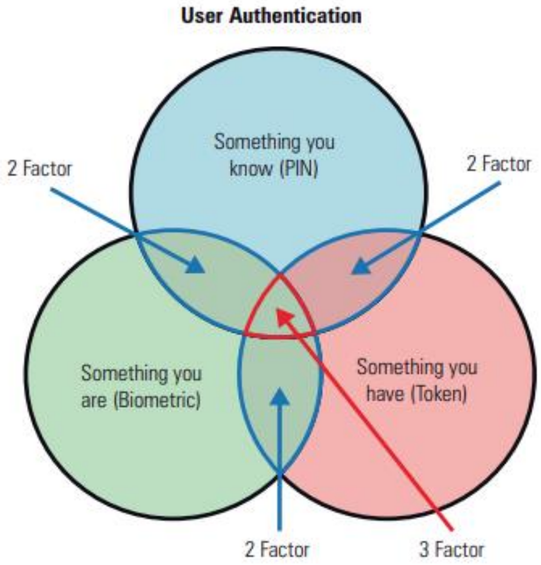
Single-factor authentication is where the user is identified against one element, i.e. something you are, such as a biometric.

### 3.1.2. Two Factors:

Two-factor authentication is where the user's credentials are checked against two elements, i.e. something the user is and knows (biometric + PIN).

### 3.1.3. Three Factors

Three-factor authentication is where a user's credentials are checked against something the user knows (PIN), has (card) and is (biometric).



# 4. Understanding Technology / Biometric systems

## 4.1. What are Biometrics?

Biometrics are the measurement and analysis of the unique physical or behavioural characteristics used to recognise humans. They work by unobtrusively matching patterns of live individuals' data in real-time against enrolled records.

Biometric data is initially read with an 'enrolment' reader and the data is then 'encoded' into a template, which is usually stored in an access control database or on a smartcard for later use. The encoding process ensures that the data cannot be reproduced from the template, only compared against a recently read sample for a pass/fail result.
Biometric sensors are either contact (i.e. the user needs to touch the sensor) or contactless (i.e. the user does not touch the sensor) technologies.

## 4.2. Types of Biometrics

### 4.2.1. Finger

Fingerprint identification has been used by police agencies worldwide since the late nineteenth century to identify both suspected criminals and the victims of crime. The technique relies on the identification of the unique pattern of ridges and furrows on the surface of the finger.

| Type | Advantages | Disadvantages |
|---|---|---|
| Contact | Speed of recognition<br>Easily understood<br>Relatively inexpensive<br>Improving accuracy | Damaged / dirty fingers<br>Sensor needs cleaning |

### 4.2.2. Vein

A vein scanner can use contact or contactless technology with an infrared light source, which excites the haemoglobin in the blood, thereby identifying the pattern of veins in the individual's hand, palm, or finger. Unlike other biometrics, the vein pattern of a human is set pre-birth and never changes.
At present, there are three main vein-matching systems on the market:

- Palm Vein
- Finger Vein
- Reverse of hand

### 4.2.1. Combined Fingerprint and Vein

A multi-format biometric reader can read both a fingerprint and/or a vein thereby providing increased security and resilience from damaged fingers.

| Type | Advantages | Disadvantages |
|---|---|---|
| Contact or contactless | As the veins are internal this is a difficult technology to forge and thus has a higher security than fingerprints. | The cost of the readers is still high due to the technology required to capture the information. |

### 4.2.2. Iris

Iris recognition uses contactless camera technology to identify the unique patterns of the ‘iris’ in an individual’s eyes. As the information is taken from a photograph of the eye, this is a less intrusive method than older retinal scanners.

Iris recognition is rarely impeded by glasses or contact lenses, and it has the smallest outlier (those who cannot use / enrol) group of all biometric technologies. Iris recognition is well-suited for “one-to-many” identification as, barring trauma, a single enrolment can last a lifetime.

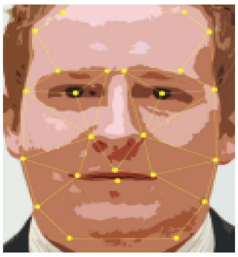
| Type | Advantages | Disadvantages |
|---|---|---|
| Contactless | Accuracy<br>Security | Price<br>Fear of use |

### 4.2.3. Facial

Facial recognition uses camera(s) to extract features from the subject’s face, such as the relative position, size, and/or shape of the eyes, nose, cheekbones, and jaw.

A newly emerging trend is three-dimensional face recognition to improve the quality of the information about the shape of a face. This information is then used to identify distinctive features on the surface of a face, such as the contour of the eye sockets, nose, and chin. This technique is not affected by changes in lighting and can identify a face from a range of viewing angles, including a profile view.

| Type | Advantages | Disadvantages |
|---|---|---|
| Contactless | Non-intrusive<br>Multi-disciplined usage<br>Hands free | Price<br>Camera positioning |

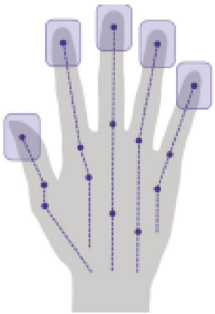


### 4.2.4. Hand geometry

Hand geometry identifies a user by the shape of their hands. Hand geometry readers use contact technology to measure a user's hand along many dimensions and compares them to previously recorded measurements.

As the human hand is not unique to an individual, hand geometry is not suitable for 'one-to-many' applications, in which a user is identified purely from the biometric, but it is suitable for one-to-one for verification of a user's identity.

| Type | Advantages | Disadvantages |
|---|---|---|
| Contactless | quicker enrolment<br>speed of use | Contact<br>Sunlight<br>physical size (aesthetics) |



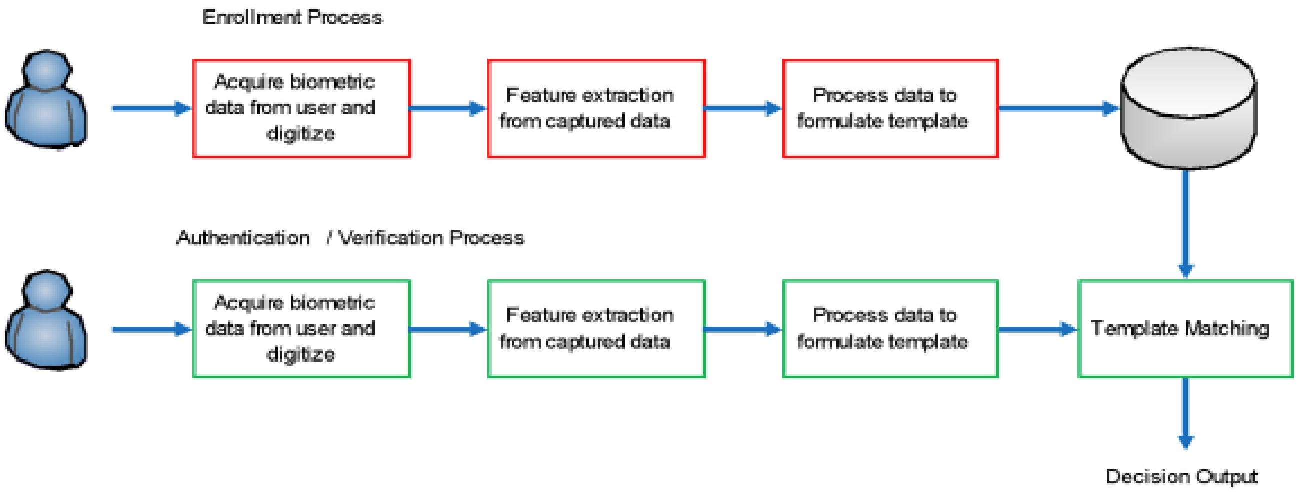
### 4.2.5. Other technique

Other technologies include voice, retina scanning, and gait recognition.

### 4.2.6. Comparison of FAR/FRR

If you are choosing a biometric system, then reference should be made to the manufacturer's data sheets to identify the suitable False Acceptance Rate (FAR) and False Reject Rate (FRR) figures applicable to your application.

## 4.3. System Architecture


Enrollment Process
Acquire biometric data from user and digitize
Feature extraction from captured data
Process data to formulate template
Authentication / Verification Process
Acquire biometric data from user and digitize
Feature extraction from captured data
Process data to formulate template
Template Matching
Decision Output

## 4.4. Advantages / Disadvantages

There are many advantages to using biometric technology. Biometric technology provides advantages over traditional card and PIN-based systems:

- Increased security level over card or PIN-based systems.
- Biometric information cannot be passed to another person in the same way a card or PIN can be.
- Reduces identification fraud at borders and at work (clocking in).
- Eliminates security threats that lost or borrowed cards and PINs create.
- System administration cost savings by removing the management of lost, stolen and forgotten cards or PINs.
- Replaces hard-to-remember passwords (which risk being shared or observed).
- Identifies Who, Where and When without any doubt.

The disadvantages of biometrics vary depending upon the technology:

- Biometric readers rarely suit an external or exposed location. In extreme cases, fingerprint readers can fail to identify users with damaged, dirty, or worn fingerprints. Not everyone can use fingerprints, and specific tasks, such as construction, can affect the user's fingerprint.
- Some biometric readers can take slightly longer to identify users than card-based systems take to allow entry due to the user normally having to stop and present themselves to the biometric readers and how the biometric information is verified.
- Users can perceive biometrics as less convenient or more intrusive than card-based systems.
- There are significant cost savings associated with the running and management of biometric systems, though the initial design and installation costs can be higher than card or PIN-based systems.
- Correct system management is critical to ensure user data protection concerns are alleviated.

## 4.5. Factors to be considered.

### 4.5.1. Speed of operation

Speed of recognition (authentication) consists of two phases. The capture phase and the authentication phase. The speed of capture depends upon the technology used and the number of points being sampled. The authentication phase depends upon the matching method. For one-to-many (1: N) matching, the time to match will depend on the database size and the search algorithm, with increasing size corresponding to increased matching time.

### 4.5.2. Level of security

The level of security offered by biometrics depends upon the type being used and its configuration. The amount of data stored within the template for matching impact the FAR/FRR figures for the product and consideration should be given as to which of these is more critical from an operational perspective.

Most systems can be configured in terms of template quality to increase or decrease the FAR/FRR figures depending on usage requirements. For example, a system that only has ten people enrolled will typically accept a higher FRR, whereas a system that has 500 people will naturally want a lower FRR.

When defining the system requirements, as well as the FAR/FRR figures, consideration should also be given to the type of authentication required to meet the security risk, i.e. 1-factor, 2-factor or 3-factor. By combining multiple technologies, the FAR/FRR figures can be increased. However, this could reduce the throughput of the reader.

The industry accepts that current iris and vein recognition systems are at the higher end of the security spectrum.

Reference should be made to the published FAR and FRR figures when selecting the level of security required.

### 4.5.3. Data Protection / Storage

The biggest issue with biometrics is the privacy argument about what and where the data is stored. Unlike the fingerprints used by the police where an image is stored, the data used for authentication is a series of 1s and 0s. It is not possible to identify an individual using the limited data stored in the template. However, there are still concerns over the location and storage of this data, which can reside in many different locations, as described below.

At one end of the scale, all templates are stored on a central server, and the reader will pass the scanned information back to the server for identification and verification.

Typically, in access control systems, the templates are stored in the reader, and the reader decides on the user's credentials, thus eliminating any template traffic across the network.

At the other end of the scale, the user's template is stored on a smart card, and a 1:1 match is performed, thereby eliminating any data protection worries.

The type of system used will be dependent upon the risk and concerns over privacy.

### 4.5.4. Security/encryption

As biometric template data is stored as a series of 1s and 0s, no reference to the individual can be obtained from the data. In theory, it could be possible to capture this data and then inject it into the network in a centralised system. However, the probability of this happening is low. For any centralised system, the data transferred between the readers and the server could be encrypted to enhance the security and resilience of the system.

### 4.6. Choosing the right Biometric

Biometrics could be used for a single high-security door on a system otherwise controlled by card or PIN. When choosing a biometric technology, the first questions that should be asked are “Why do we need biometrics?” and “What is our security risk?”

Biometric technologies provide high-security protection, though the reasons to choose biometrics may not be due to high security. The requirement may be for a solution that reduces the administration and management of cards or PINs.

Do you want biometrics only or a mix of traditional access readers and biometrics? Again, this will depend upon what you are trying to protect. Most biometric readers will provide an output to integrate with an access control system.

Systems must be designed carefully considering how many users need to enter or exit at any time. i.e. Will the speed of the reader and entry point open/close time cause any backlogs? Or will additional entry and exit routes be required?

For realistic operation, the authentication process should typically take less than 3 seconds. Otherwise, the usability will be questioned.

Considerations for any access control system:

- Volume of traffic.
- Identification v verification.
- Speed of operation.
- Security Level Required.
- Application Type – e.g., builders, office workers.
- Disability Discrimination Act (DDA) and Equality Act.
- Reader Locations.
- Future Expansion.
- Time and Attendance.

## 5. Legal matters

Users of access control systems and biometric technologies should comply with all applicable discrimination legislation and the Data Protection Act. They should apply the recommendations of the Information Commissioner’s “Employment Practices Code”.

This document was created by the Access and Asset Protection Section of the British Security Industry Association (BSIA).

The British Security Industry Association is the trade association for the private security industry in the UK. Our members provide over 70% of UK security products and services and adhere to strict quality standards.

The British Security Industry Association's Access and Asset Protection Section brings together companies involved in security, providing physical products to stop unwanted people from accessing property or valuables and electronic measures that can, optionally, control them.

The section includes member companies involved in the manufacture, supply, and installation of solutions that. restrict, control, and monitor the movement of people, assets, or vehicles in, out and around a building or site. It includes physical protection methods, such as security doors, fencing, locks, barriers, safes, and strong rooms, rising screens, etc., and the electronic access control systems that control them and allow authorised persons in and keep undesired people out.
Access control products are subject to fast-moving technological development. The section aims to raise awareness amongst end-users and specifiers of the different types of equipment that are available, the applicable standards and the most appropriate environments for using them.

The Access and Asset Protection Section sits in a strong position when lobbying for consistent standards and regulations. Access control products are subject to fast-moving technological development. A major focus of the section is to raise awareness amongst end-users and specifiers of the different types of equipment that are available and the most appropriate environments for using them.

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