FINGERPRINTS

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Fingerprint Sensor Integration Guideline

Guideline

Revision 3.2

Contents

1 Overview

Biometrics is a technology based on identification of individuals by a physical or behavioural characteristic. Examples of recognition of physical characteristics are fingerprints, retina, iris, and face or hand/finger geometry. Behavioural characteristic can be the voice, signature or other keystroke dynamics.

One of the most widely known techniques is based on fingerprint recognition. The basic idea is that all fingerprints are unique, both different from one another and from those of every other person [reference: Grimnes S, Martinsen Ö G Bioimpedance & Bioelectricity Academic Press]. The fingerprint pattern is composed of friction ridges that form the unique combination of distinguishing features of each finger. Combined with the fact that fingerprint characteristics do not vary in time, make fingerprints idealistic for personal digital identification.

There are several issues to consider when optimizing a biometric system. In addition to the fingerprint technology itself, the two most important topics are enrolment methodology and user ergonomics. They are, as well as the fingerprint technology, directly related to the quality measurements of the system.

1.1 Purpose

The purpose of this document is to give an introduction how to in a good way integrate a fingerprint sensor and achieve optimal performance.

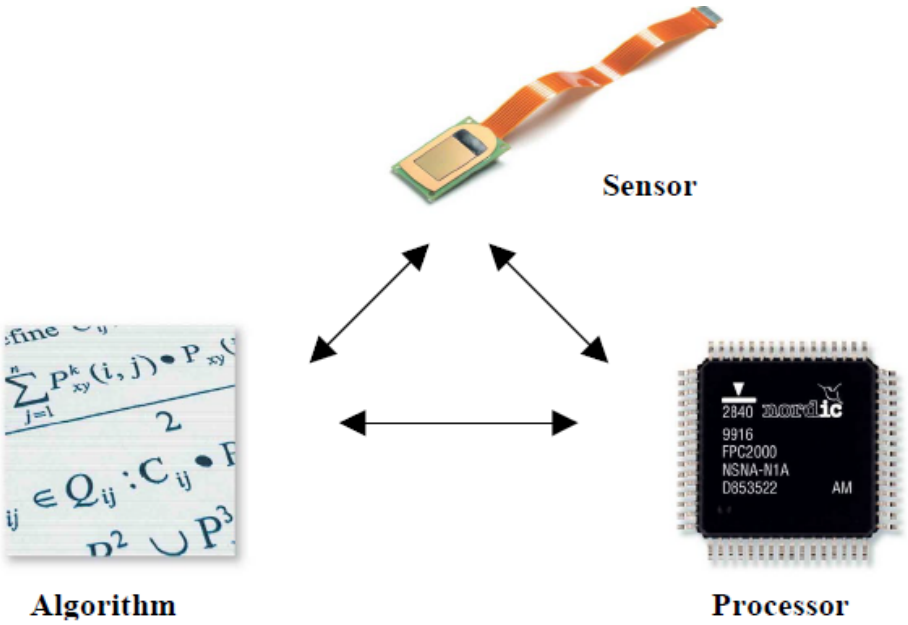
1.2 Terminology

FPC	Fingerprint Cards
HW	Hardware

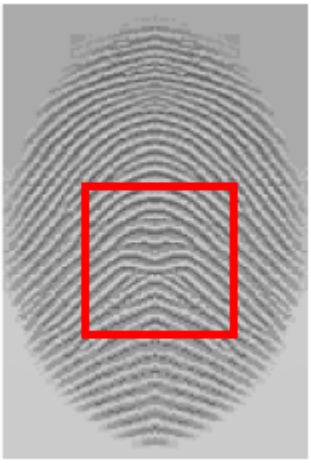
2 System

2.1 Fingerprint System

The basic components in the FPC system are the sensor, the specially designed microprocessor and the algorithms for registration and verification (fig.1).



Fingerprint patterns are made up of shapes, which determine the general classification characteristics of the print. In all fingerprints a center part can be found, which is called the fingerprint core. The area surrounding the core holds many of the interesting fingerprint characteristics that are unique for each individual.



3 Defintion of crucial events

3.1 Translation

According to the fingerprint and system characteristics described above, general conclusions can be extracted regarding placement of the finger:

• Repeatability: The finger should preferably be placed in the same position every time.

• The fingertip should cover the whole sensor surface.

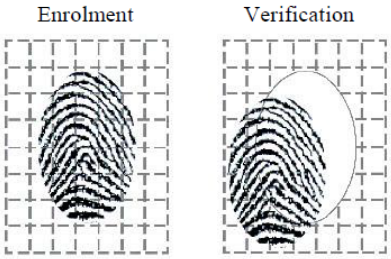
• The fingerprint core should be placed as near the sensor center as possible.

Fingerprint recognition systems are limited by the amount of calculations needed for authentication, and the number of iterations can be reduced by means of fingertip guidance. There are several difficult situations, which can arise when the using the system, mainly divided into four sectors; translation, rotation, finger pitch and finger roll.

2.1. Translation

Definition

Translation can be defined as the difference in horizontal and/or vertical direction from the enrolled template to the verification occasion.



System requirements

The algorithm allows a few millimeters in both horizontal and vertical direction (between the enrolled fingerprint and the verified fingerprint).

Translation is essentially a result of the lack of guidance of the fingertip in both directions. The level of translation depends also on the finger size. If the user has small fingers, there is more space for the finger to move around, compared to a bigger finger.

3.2 Rotation

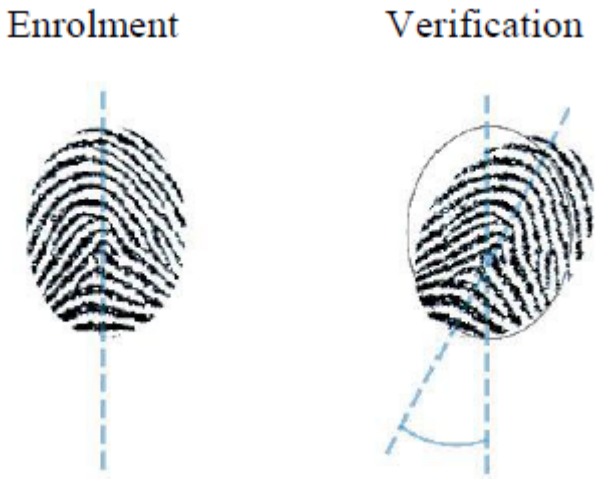
Definition

The rotation is defined as the angle difference between an imagined centerline of the finger from one occasion to another.

System requirements

The algorithm allows some variation from the enrolment occasion. But when the rotation exceeds a certain degree, there will be trouble for the algorithms to handle this variation.

Possible reasons for rotation can be that the sensor lies in the same plane as the rest of the application, or simply insufficient support along the side of the sensor. The finger can also be too small which results in a residual area where rotation can take place.



3.3 Finger pitch

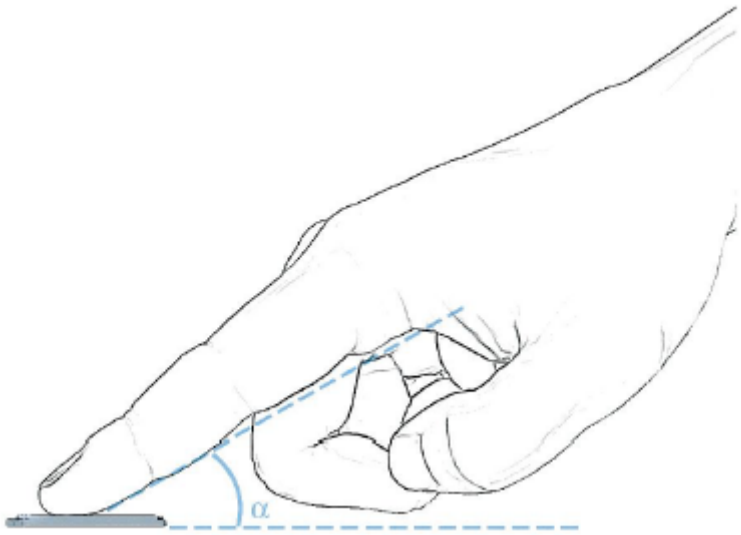
Definition

Pitch occurs when only the upper part of the fingertip is placed on the sensor, as if the user points at something.

System requirements

Due to the fact that the upper parts of all fingerprints look very much alike (parallel curves) and there are very few distinct areas, this situation has to be thoroughly considered. The system needs fingerprints with enough information, and also the sensor area has to be covered satisfactory. This problem is either caused by lack of knowledge of biometric technology, (i.e. the user does not know the importance of placing the whole fingertip on the sensor), or a lack of knowledge of the fingertip characteristics (i.e. the user does not know where the crucial information is positioned).

Another possible reason to this situation is that the user tries to press down the sensor as if it is a button.



3.4 Finger roll

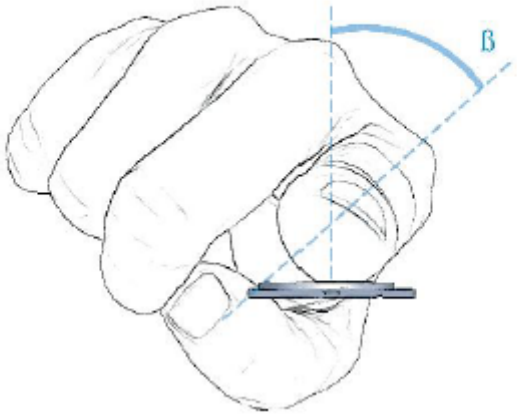
Definition

Finger roll is defined as an incorrect positioning regarding tipping the finger in the sideway directions.

System requirements

As the situation above (finger pitch) the fingerprint recognition system has to receive enough information.

If the finger is big enough and/or the tipping is not too heavy, sufficient information can be captured. The reasons why this problem occurs can be an incorrect place of the user, the sensor in relation to the body of the user.



4 Influencing parameters

4.1 Ergonomics in general

The ergonomic considerations vary depending on which type of applications the FPC system is integrated into (for example smart cards, wireless applications, IT security, physical access, time & attendance, automobile). Generally, the most natural position of the body is preferred.

- Position - standing

If the user is standing, the relative position to the sensor application is crucial. When integrating a technical system in different environments, one important parameter is to try to adapt the system into the regular behavior of the user. If for example the physical access unit is positioned besides the door, it might lead to one of the four main problems described earlier.

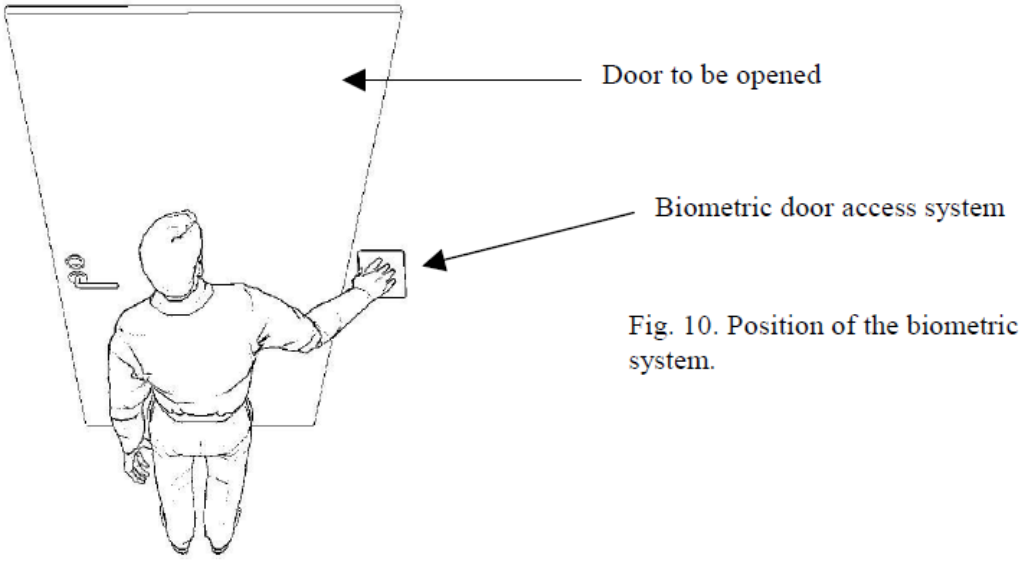


Fig. 10. Position of the biometric system.

Another essential parameter is at which height the biometric system is placed. If the system is placed too low, the finger pitch situation will arise, and if it is placed too high the user cannot see where to position the fingertip.

- Position - sitting

When the user is sitting, other parameters have to be taken into account. The device has to be placed within a reasonable reach and it has to be positioned considering the natural posture of the user.

- Ability to see the sensor

The ability to see the sensor area is an important parameter, especially for untrained users. If the sensor is hidden or placed where the user cannot see it, the performance might decrease if the user is not well trained for the system. It is obvious an advantage to see the sensor, but the design should of course aim at a good performance even though the user cannot see where the sensor is.

4.2 The importance of feedback

When developing and using technical systems of different kinds, the importance of feedback should be addressed. If the user receives some kind of response from the system, the uncertainty will be reduced whether the system approve the user or not.

Even if the user has not approached the system correctly, the need to confirm this is necessary to consider. There are two main issues to regard when implementing a feedback function; which function and what level should the feedback react on, and how should the feedback signal appear?

Different levels of feedback:

• Accepted – Not accepted

• Adjust the finger – Try again

• System performance – does it work at all?

• Display how correct the user has placed the finger

Examples of signal types:

• Red diode – Green diode

• Bar chart

• Beeps (like crossings)

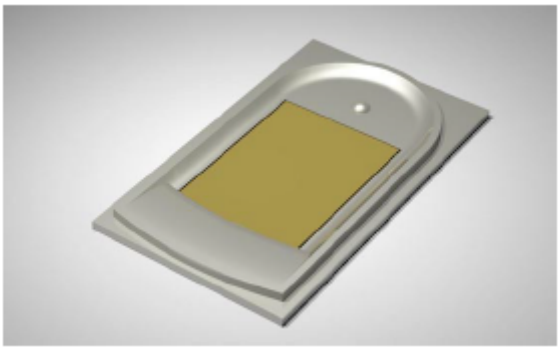
• Display with test boxes

The feedback signal should be adjusted to the application, the function of the signal should be enough clear but not be too deviant from the application. The system integrator need to consider parameters as size, color, sound and further instructions to fit the application in question the best.

The extent of the feedback can be related to the complexity of the application: the more complicated device, the more important role of the feedback. It is also related to the amount of time or how many actions the use of the system demands.

4.3 Solutions

The most important feature to avoid translation is the support of the surrounding parts of the sensor. To create sufficient guidance, there are several solutions to consider. The frame surrounding the sensor is designed to guide the fingertip at the lowest level of guidance. The sensor frame is made as a “target” in order to guide the fingertip in the correct position.

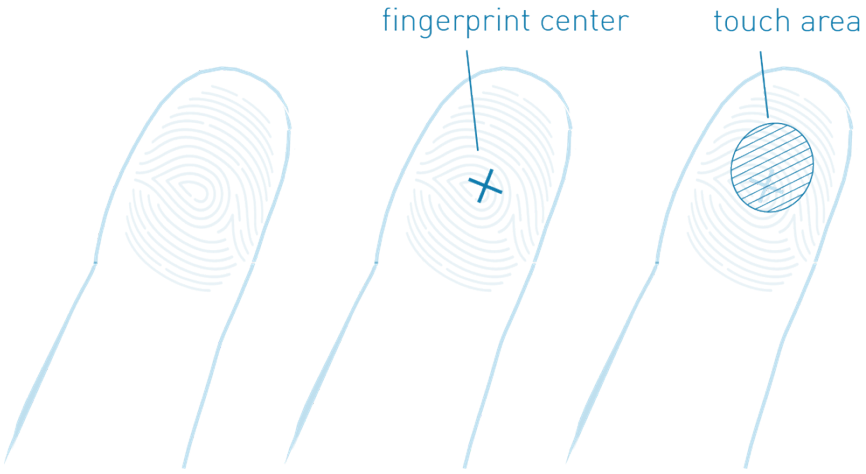


Another solution is to design the nearest surrounding part to force the finger to be placed correctly. Building up a structure that resembles a valley-ridge structure where the finger is to be placed in the groove is effective to limit the variation in the x-direction. By designing this structure as narrow as possible the finger will go down in the valley in a satisfactory way.

4.4 Tactile feedback

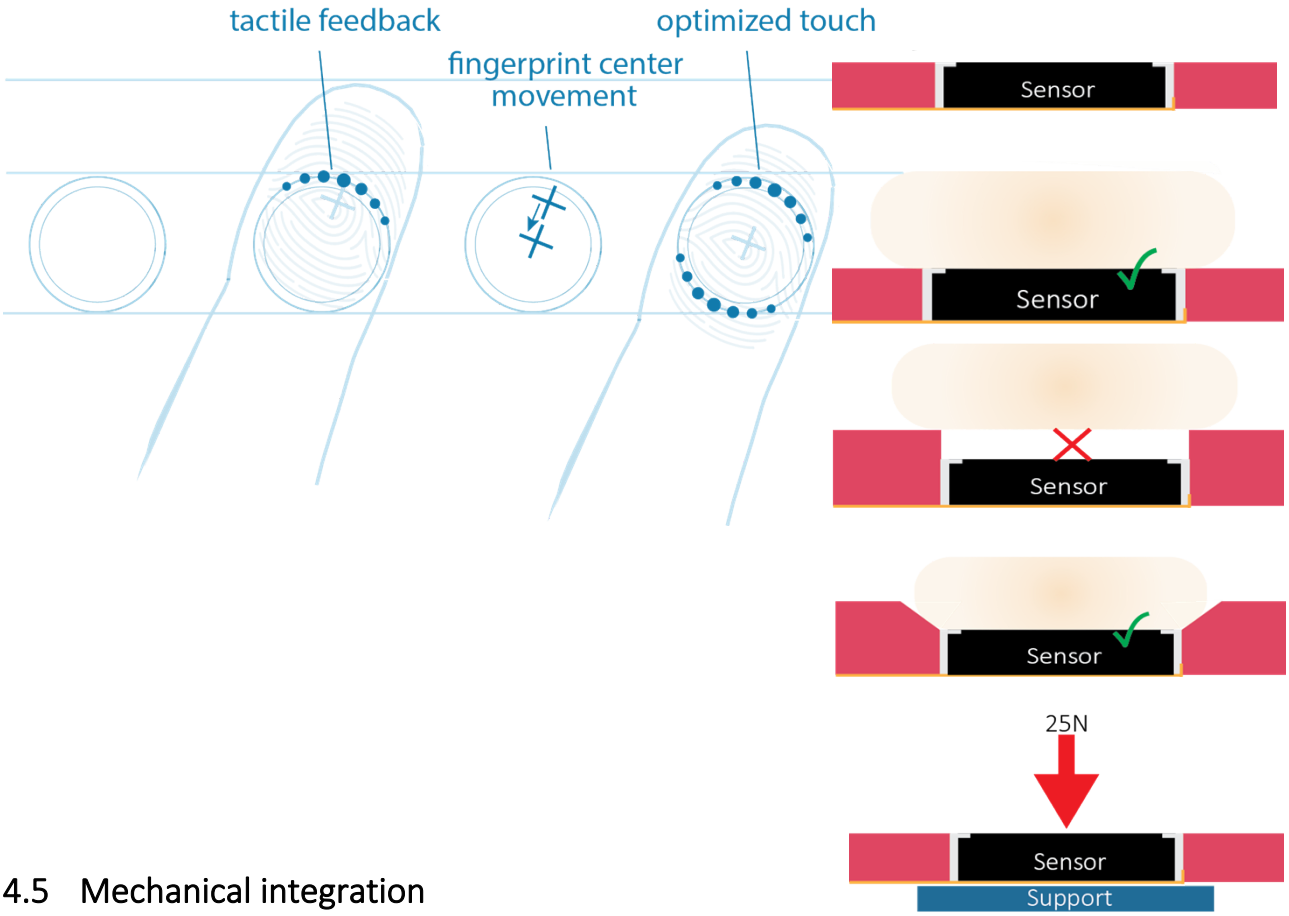
-A fingertip is most sensitive in the middle of your finger (touch area)

-The density of biometric data is highest in the middle of the fingerprint. (fingerprint center)



In order to enable the user to get an optimal touch with the sensor, it is important that the user receives tactile feedback.

1. The user places the fingertip on the edge of the sensor. The reason for this is that the feedback allows the user to easily locate the fingerprint module.
2. The intention is then to move your finger so that the touch is optimized. This makes the user by dragging the finger over the sensor until the fingertip is in the center of the fingerprint module.
3. The user unlocks the action when there is tactile feedback both on the lower and upper fingers.



4.5 Mechanical integration

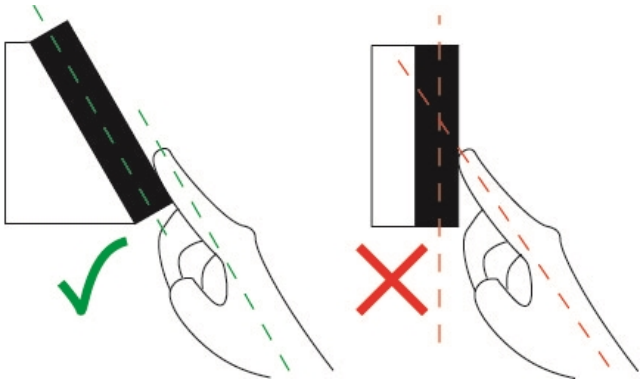
Align the sensor with the surrounding component

- To make the sensor accessible for good fingerprint reading, the whole sensor and bezel area should be exposed to the fingerprint
- The sensor should be placed slightly lower than the surrounding component to give tactical feeling of sensor

- The sensor adjacent edges shall not be too high that a finger lift effect is seen

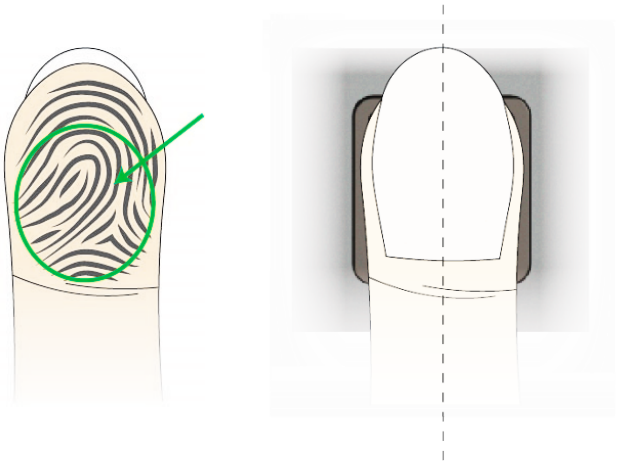
4.6 Ergonomics

- Angle the sensor module in a way that makes the user expose the correct part of the fingerprint to the sensor, through a natural grip



4.7 Fingerplacement

- Following are some general information on how to properly put your finger on the sensor
  - The lower part of the fingertip should be exposed to the sensor, as shown in in the upper left picture
  - The sensor needs to be fully covered by the finger
  - Keep the finger straight and fully parallel to the sensor, as shown in the upper right and lower pictures



5 Document History

Revision	Changes
1	First revision.
2	Updated to correct template

Table 1: Document History