Biometric Authentication using Online Signature

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Outline

Introduction

An example of authentication scheme

Performance analysis and possible improvements

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1. something you *know*;
2. something you *have*;
3. something you *are*.

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It extracts from the signature some information like: time stamp, pressure, coordinates x and y, ...

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- analysis requires no invasive measurements.

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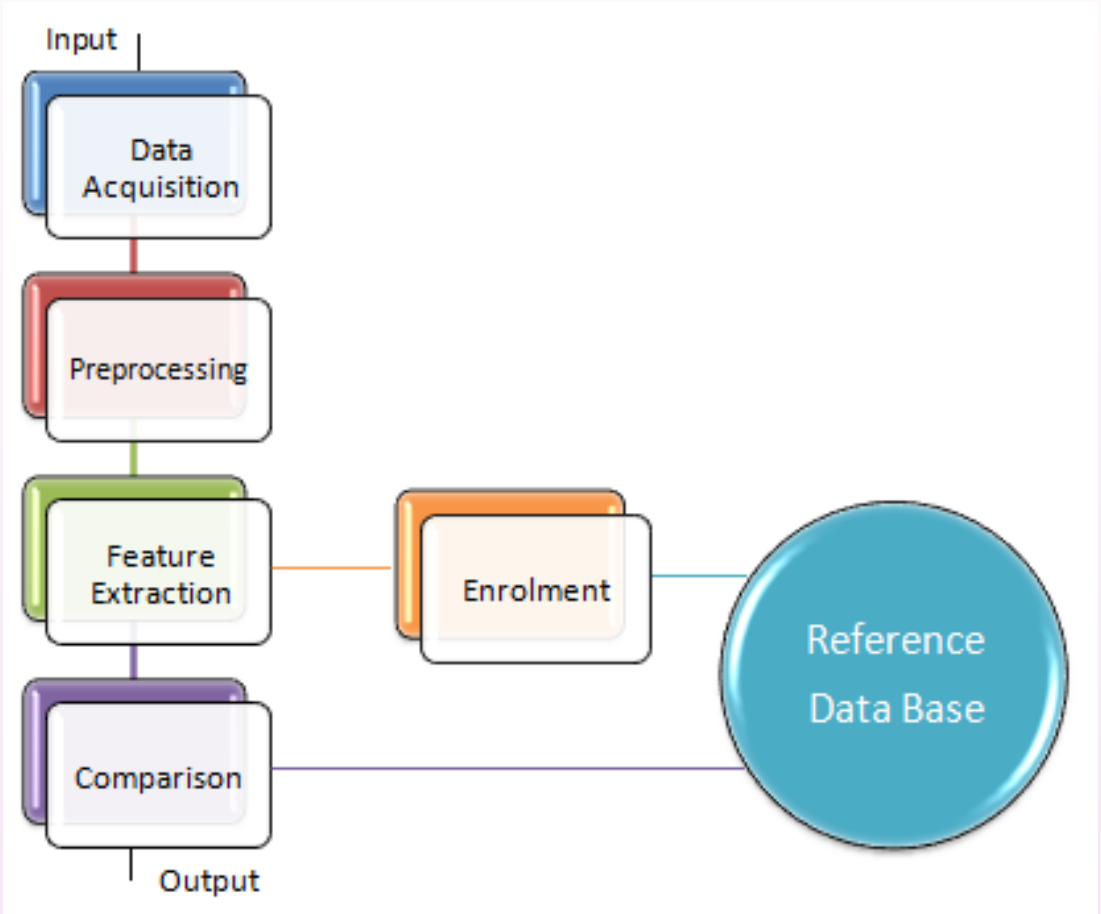
Typical Verification Process



Our Algorithm

The algorithm consists of 3 main steps

1. **Training**: step necessary to compute time thresholds and the values used during the binarization phase;
2. **Enrollment**: the steps the algorithm follows when a new user is enrolled into the system;
3. **Authentication**: the steps the algorithm follows when a user needs to verify his gesture.

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Training

For this step we need a training database, representative of the population we want to enrol into the system.

The tablet extracts some or all of the following data per gesture:

- spatial coordinates X and Y ;
- a time-stamp, T;
- pressure, P;
- event type, E
- event ID - different touch events have different ID when they are simultaneously in contact with the device.

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Feature Extraction

Starting from this data, we computed a total of 63 features for each gesture.

ID	Description	ID	Description	ID	Description
1	Number of Sample	19,21,23,25	Y Local Acceleration	49	Height
2	Time Duration	26-27	X and Y Absolute Mean Velocity	50	Y Maximum
3	Aspect Ratio	28-29	X and Y Initial Value	51	Y Minimum
4-5	X and Y Areas	30-31	X and Y Final Value	52	Y Mean
6	X Mean Velocity	32-35	Statistic Moments $M_{1,1}$,$M_{1,2}$,$M_{2,1}$, $M_{0,3}$	53	Pressure Mean
7	X Mean Acceleration	37-40	X Local Area	54	Pressure Maximum
8	Y Mean Velocity	41-44	Y Local Area	55	Pressure Minimum
9	Y Mean Acceleration	45	Width	56-57	X and Y Maximum Velocity
10,12,14,16	X Local Velocity	46	X Maximum	58-61	Pressure Local Area
11,13,15,17	X Local Acceleration	47	X Minimun	62	X Peak Number
18,20,22,24	Y Local Velocity	48	X Mean	63	Y Peak Number

Training

From the training database we calculate the following values:

- *four time thresholds* th_1, th_2, th_3, th_4 (Time Threshold Control);
- *three medians* m_1, M, m_2 for each feature (Binarization process)

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Enrollment

- 5 biometric measurements are recorded for each user;
- The mean time duration T is compared to the four time thresholds computed during the training stage, obtaining `Fascia_temp`.
- For each feature the median value is compared to m_1, M, m_2 in order to assign it one of the following strings $\{1011, 1111, 0111, 0101\}$ obtaining the vector B.

  The same process is applied to each of the five feature vectors, obtaining the vectors b_1, b_2, b_3, b_4, b_5

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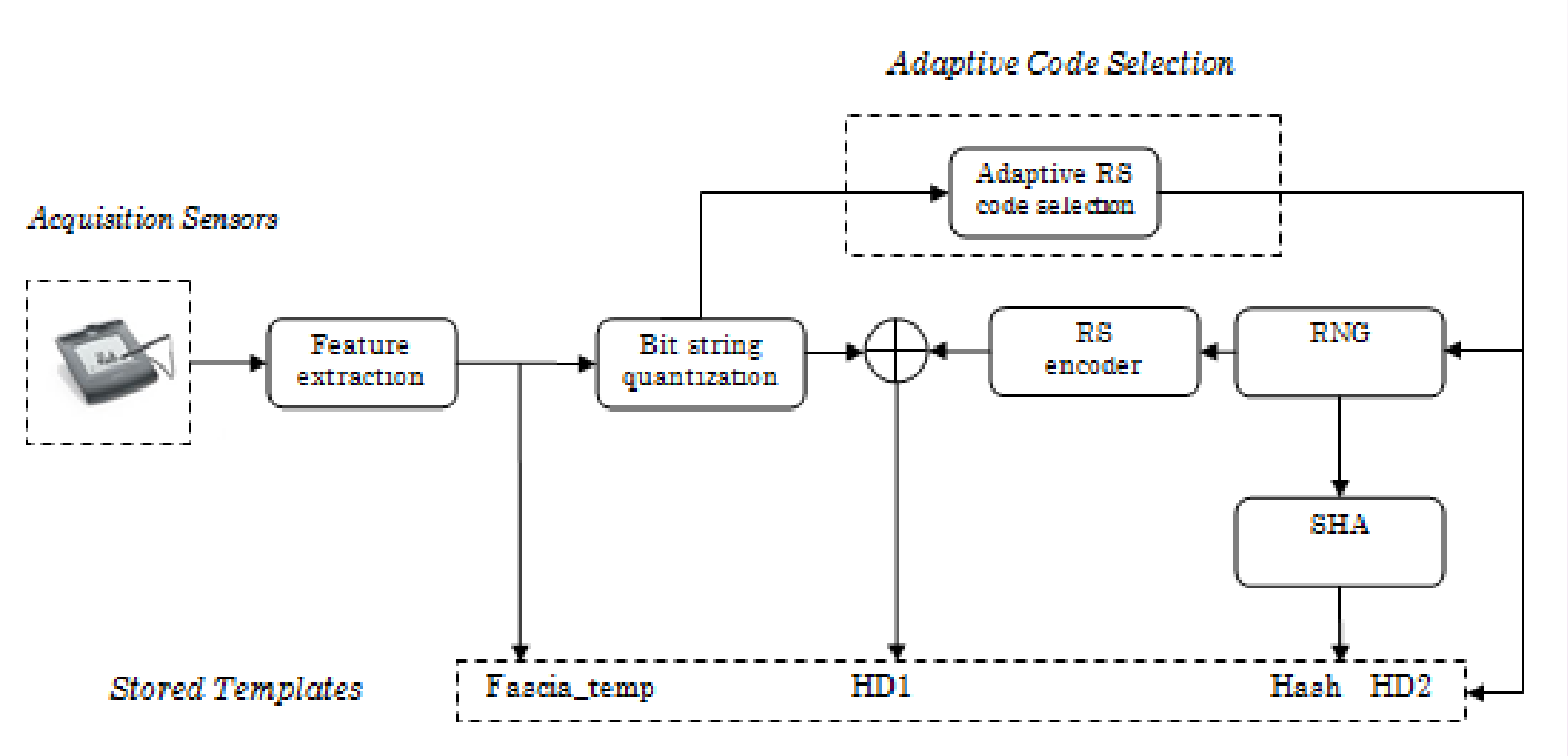
Adaptive Code Selection
Adaptive RS code selection
Acquisition Sensors
Feature extraction
Bit string quantization
RS encoder
RNG
SHA
Stored Templates
Fascia_temp
HD1
Hash
HD2

Stored templates

The system saves the following data:

- m_1, M, m_2
- HD_1, the sum between the binarized vector B and the code word obtain for each user s
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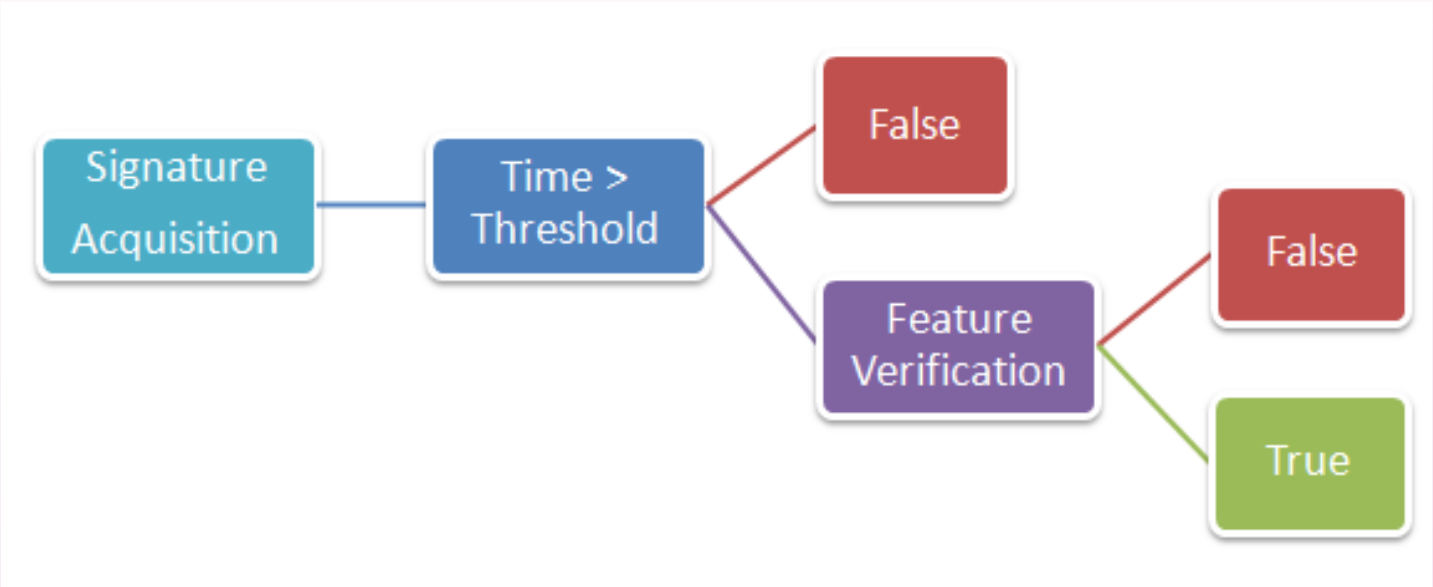
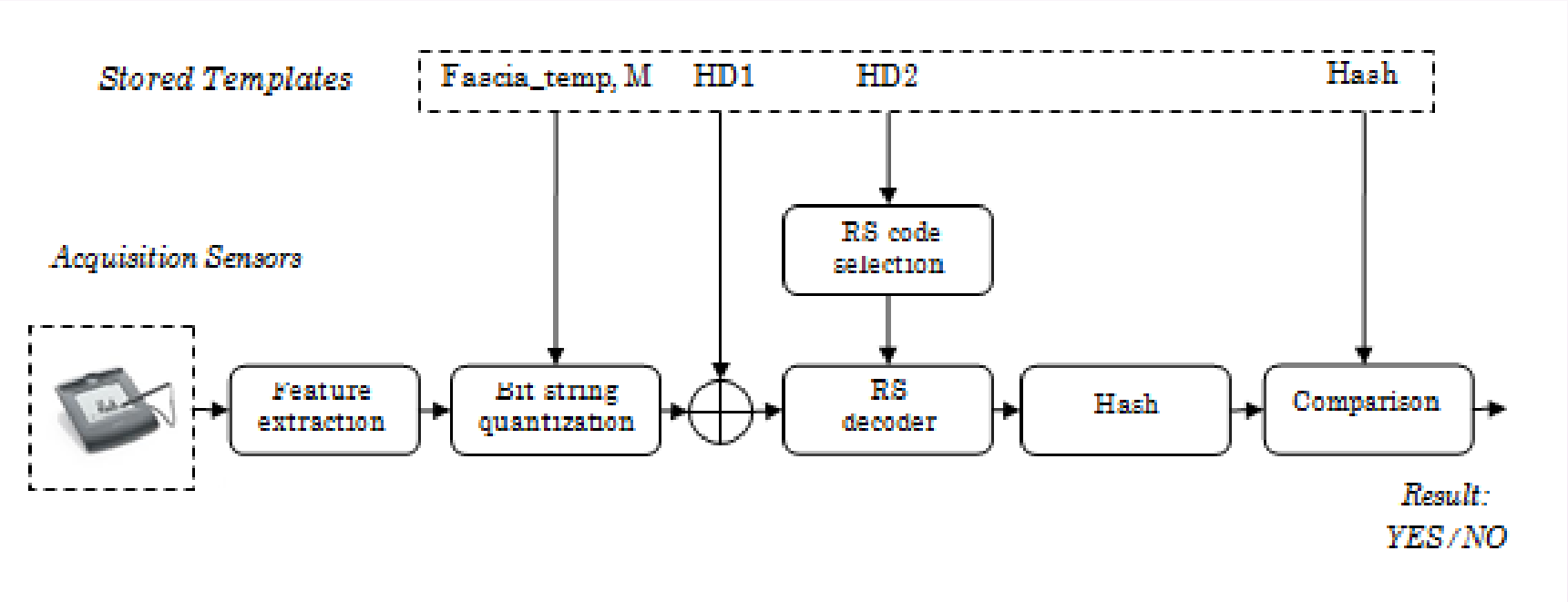


Figure : Scheme representing how the time threshold will be used.

Feature analysis



Performance Evaluation

Evaluating a verification system requires the analysis of two types of errors:

1. **False Acceptance Rate** (**FAR**): rate of incorrectly accepted forgeries
2. **False Rejection Rate** (**FRR**): rate of genuine signatures that are incorrectly rejected by the system

Results

Different choices of *time thresholds* and *code correction capability* lead to different percentages.

Allowing the user to have a *second* signature attempt in case the first one fails to authenticate, the best results achieved with the used database are:

$$\text{FAR} = 1.91\% \qquad \text{FRR} = 6.66\%$$

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Possible improvements

Many modifications are possible that can enhance the performance of the previous algorithm.
For example, one can change

- the extracted set of features;
- the encoding scheme;
- the binarization process

(in order to test your new verification scheme you could need a database containing genuine and forgery signatures).

Thank you for attention!