Finger veins based recognition system

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Information and Communication Engineering

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PROJECT GOAL

Build a ''state of the art'' biometric recognition system based on veins detection, recognition and matching.

Why:

Veins recognition system is a hot topic in research and it is the state of the art in biometric authetication.
As we can see in [1] veins recognition is the best security/cost ratio method for biometric recognition.

Extra Security Level:

Vein patterns of individual's and finger veinis difficult to replicate (there are no traces left because it is contactless) and also it can be captured only if the subject is alive because deoxygenated hemoglobin is present in the body [2].

References:

[1]Systematic Review of Finger Vein Recognition Techniques
[2]Finger Vein Recognition Using Minutiae Extraction and Curve Analysis

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Registration

Register user to the database and make a vein pattern model for every user under the defined specification

Authentication

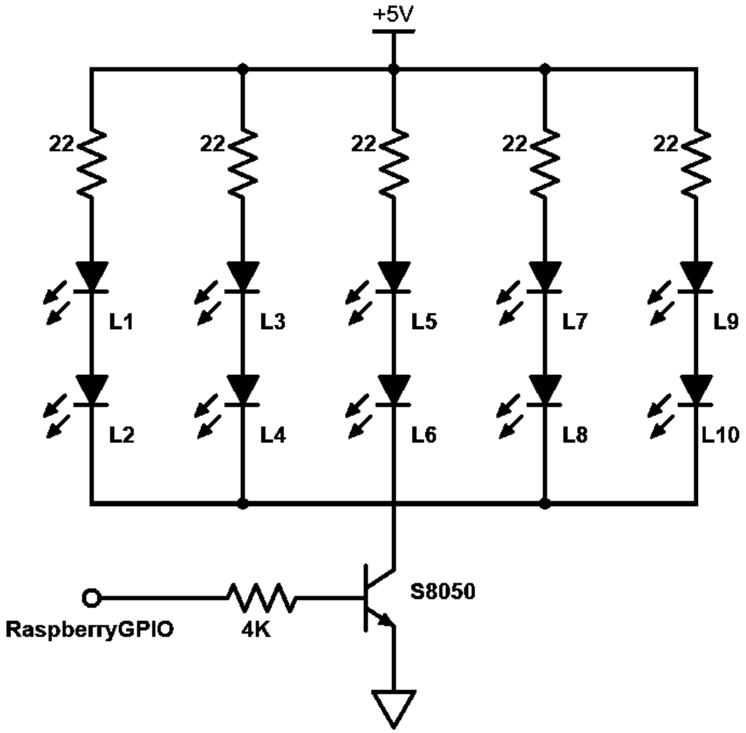
Take a finger photo and apply preprocessing algorithms on taken image for building a template that respect the defined specifications

Matching

Apply image processing algorithms for feature detection, extraction and matching between the two obtained templates (from registration and authantication phases) and produce a result

Hardware

For taking the image of the finger veins pattern we exploit the light trasmission tecnique using 10 NIR (760 nm wavelength) provided by EPIGAP Optronic GmbH for research purpose and a simply Raspberry Pi with the NOIR camera module



$$I_{LED} = 30mA$$

$$I_C = 5I_{LED} = 150mA$$

$$V_{BE} = V_{BE\gamma} = 1V$$

$$V_{CESAT} = 0.5V$$

$$V_{LED} = 1.8V$$

$$h_{FE} = 150$$

$$I_C = h_{FE} I_B$$

$$5 = R_B I_B + V_{BE\gamma} = 1V$$

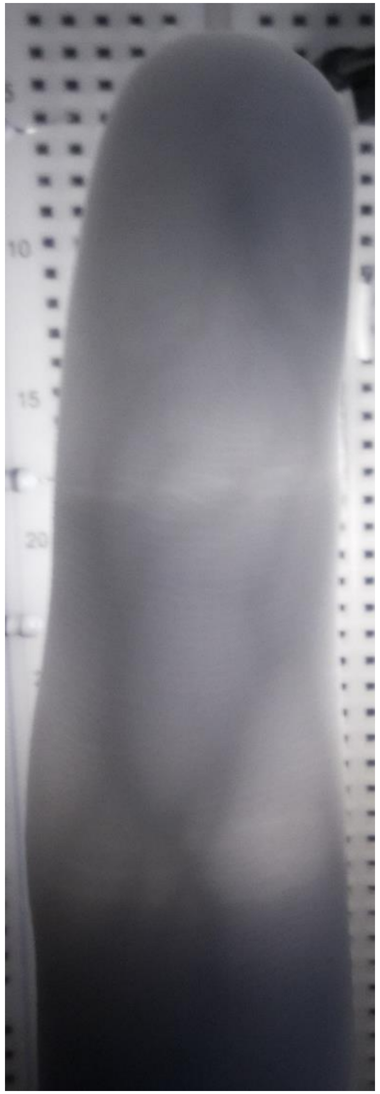
$$R_B = \frac{4}{I_B} = \frac{4h_{FE}}{I_C} = 4K\Omega$$

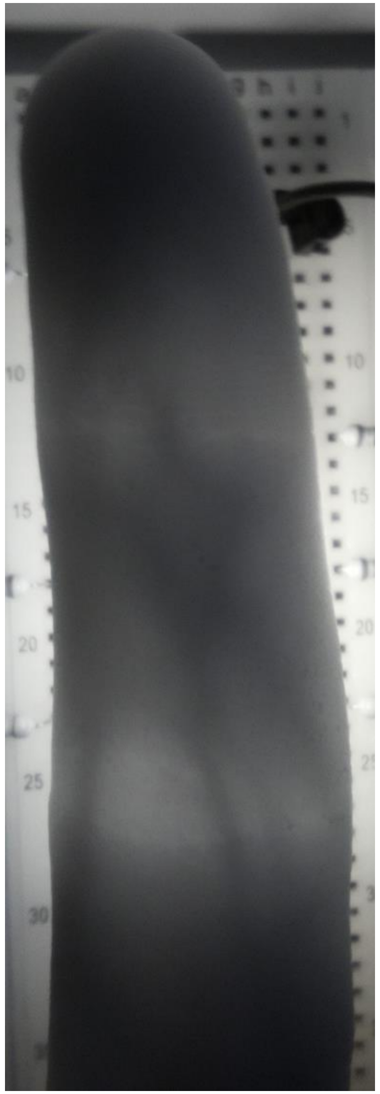
$$V_{LED} = 1.8V$$

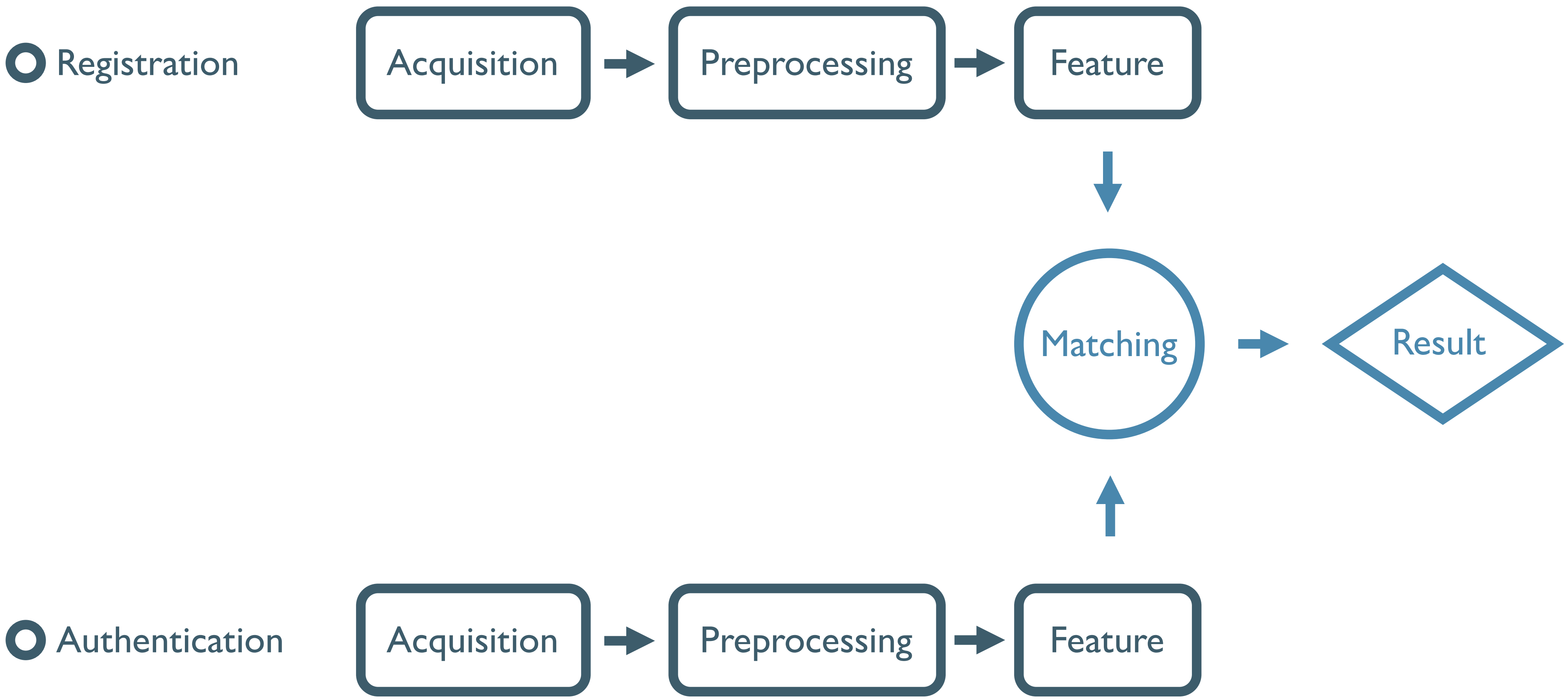
$$R_{LED} = \frac{5 - 2V_{LED} - V_{CESAT}}{I_{LED}} \simeq 30\Omega$$

Test

Some raw data images that we have taken with our prototype, the first one shows the Eduards veins pattern and the second one the Alessandro veins pattern






Registration
Acquisition
Preprocessing
Feature
Matching
Result
Authentication
Acquisition
Preprocessing
Feature

Preprocessing, model making

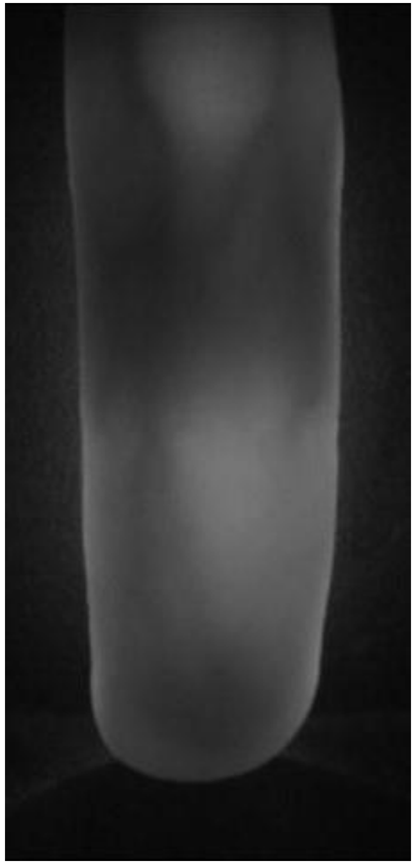
In the preprocessing phase we want to obtain a template that respect the following specification from 6 raw data images taken in different positions

- Size of 200x50
  Represent the central part of the finger
- Veins should be mostly connected
  Veins tickness > n pixels

ROI Extraction → **Enhancement** → **Thresholding** → **Opening** → **Resize**

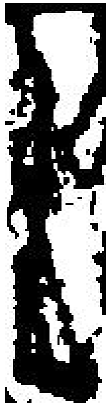
- **ROI Extraction**: Find extreme points of the finger and cut
- **Enhancement**: Subtract the mean value and divide by the dynamic range
- **Thresholding**: NiBlack method
- **Opening**: Clears noise
- **Resize**: Resize image to 200x50

Test



Preprocessing

A model obtained by the raw data image using the preprocessing implemented algorithms



Matching

In the matching phase we want to compare the two template obtained through the preprocessing algorithms for the enrollment/registration and for the authentication phase

LBP code is a binary local pattern code obtained by taking the cross correlation between a binary image and a specific kernel composed by the powers of 2. The result of the cross correlation is used like a 8 bit binary code.

LBP Code → **Hamming distance**

$$\begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 1 \\ 1 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 1 & 2 & 4 \\ 128 & 0 & 8 \\ 64 & 32 & 16 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 128 & 0 & 8 \\ 64 & 0 & 16 \end{bmatrix}$$

$$LBP_{DECIMAL} = sum(I \otimes K)$$

$$LBP_{DECIMAL} = 217 \rightarrow LBP_{BINARY} = 11011001$$

$$HD = sum(LBP_{ACQUISITION}\ XOR\ LBP_{MODEL})$$

The hamming distance is simply the number of bit that are different and it is obtained counting the number of 1 of the result of the XOR operation between two LBP code

Thanks for attention

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