INSTITUTO SUPERIOR DE ENGENHARIA DE LISBOA
LICENCIATURA EM ENGENHARIA INFORMÁTICA E DE COMPUTADORES
MESTRADO EM ENGENHARIA INFORMÁTICA E DE COMPUTADORES
IMAGE PROCESSING AND BIOMETRICS

Laboratory Project 2 - 2nd semester, 2015/2016 (May, 20)

Due Date (Code and Report): July, 4

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1. The Web safe colors, `https://en.wikipedia.org/wiki/Web_colors` are an important aspect in the development of informatic applications that deal with color.

   a) Write a function/method that: counts the number of unique colors in a RGB image; checks if the image is RGB safe.

   b) Write a function/method that transforms an RGB image to a safe RGB image, by changing each color to the closest safe color.

2. The set of images `colorImages.zip` contains several color images from three different biometric traits. For each image, we have the original version (depicted in Figure 1) as well as four distorted/noisy images.

   a) For each of the 12 distorted/noisy images, identify the source or type of distortion/noise.

   b) For each distorted/noisy image, propose and apply adequate techniques to restore the original image. Report some experimental results using the image assessment measures, defined in Laboratory Project 1.

Figure 1: The original color images from different biometric traits: iris, face, and facial thermogram.

3. Consider the problem of generating small color images with four letters (and/or numbers), as the one highligthed on the rigth-hand-side of Figure 2. These images usually appear in Web applications to assure that the user is really a human being (*I'm not a robot*) and to prevent some software automated actions.

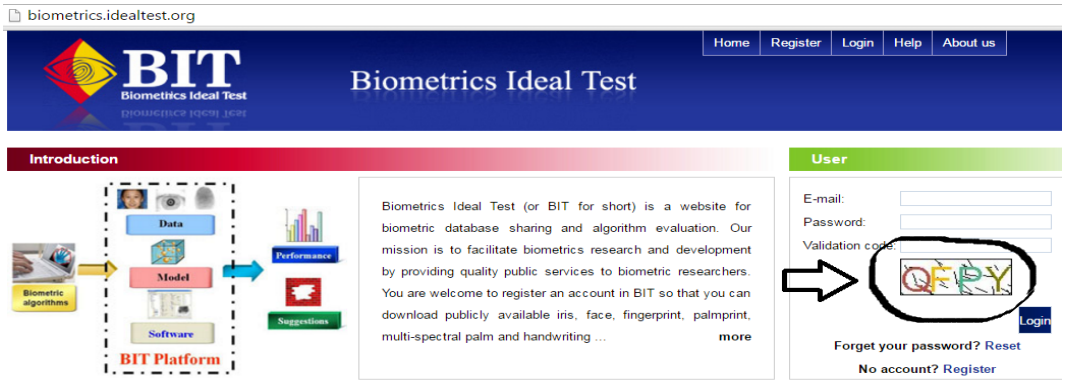

Figure 2: A Website requiring that the user inputs a code for verification.

Develop a CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart) application for this purpose, `https://en.wikipedia.org/wiki/CAPTCHA`. Propose an algorithm to generate this type of images. The randomly generated images should contain only Web safe colors. Describe all the steps taken by the proposed algorithm and report some experimental results, using 10 images stored as PNG files.

4. The following paper, available at `http://www.sepi.esimez.ipn.mx/manuscritos/V12N1_009_016.pdf`,

   G. Aguilar, G. Sánchez, K. Toscano, M. Nakano-Miyatake, H. Pérez-Meana, *Automatic Fingerprint Recognition System Using Fast Fourier Transform and Gabor Filters*, Científica, Vol. 12, n. 1, pp. 9-16, 2008.

   proposes fingerprint enhancement techniques as well as minutia detection procedures, in order to build a fingerprint recognition system. The `fingerprintDB.zip` file contains a set of fingerprint images, which were acquired with the same sensor from four different individuals.

   a) From the set of techniques for fingerprint enhancement proposed in the paper, write code to apply some of these techniques. Show some experimental results.

   b) Using the enhanced fingerprint image, devise an algorithm to detect the minutia on the fingerprint image. Show some experimental results.

5. Develop a module for fingerprint recognition (for both authentication and identification), for the four individuals in `fingerprintDB.zip`. This module will use features extracted from the images obtained in exercise 4. Show some experimental results of the recognition rate of the module. For this problem, you may consider the following resources (depicted in Figure 3):

   - OpenCV, available at `http://opencv.org/`, an open source computer vision and machine learning software library.
   - SFinGe, Synthetic Fingerprint Generator available at `http://biolab.csr.unibo.it/research.asp?organize=Activities&select=&selObj=111&pathSubj=111&Req=&`.
   - Weka, available at `http://www.cs.waikato.ac.nz/ml/weka/`, a collection of machine learning algorithms for data mining tasks.

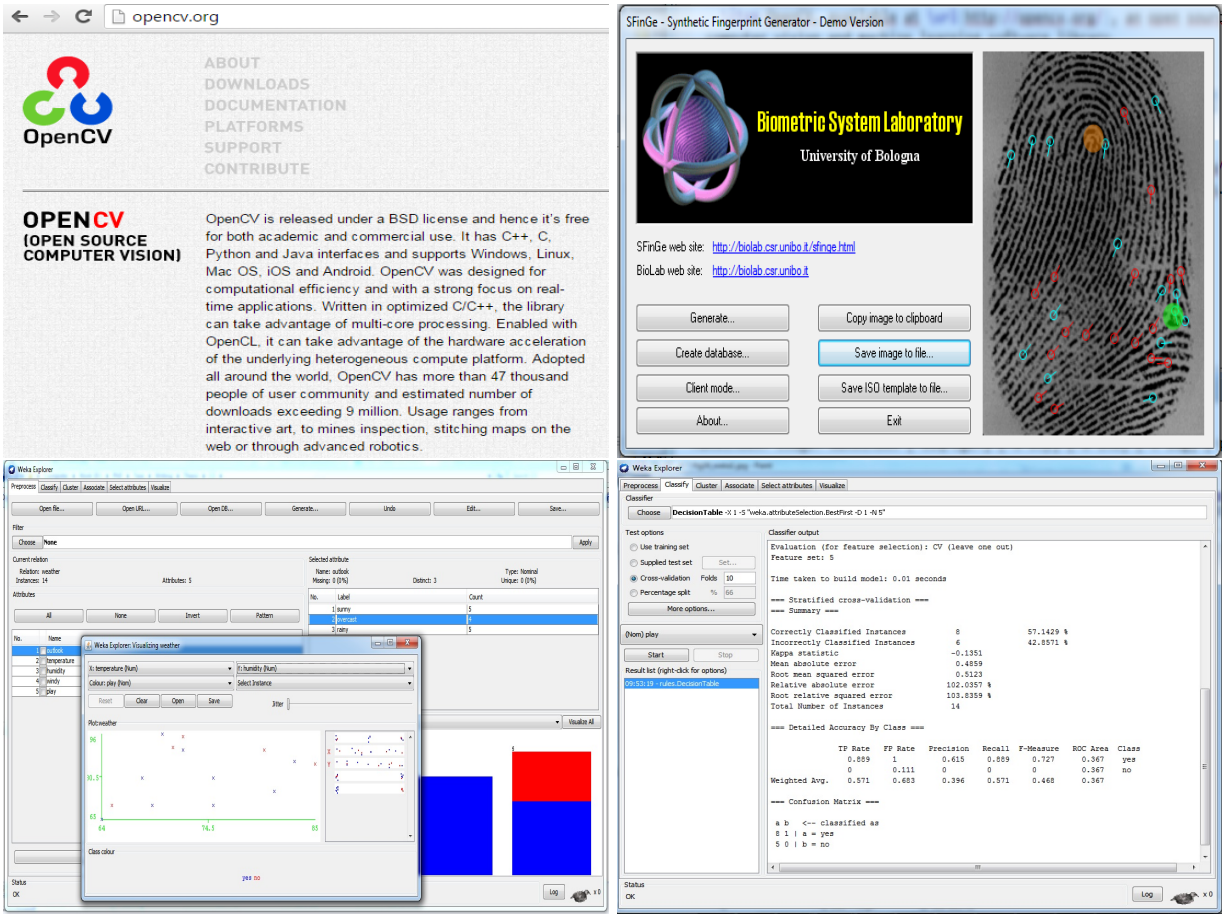

Figure 3: Tools for computer vision and machine learning. Top: the OpenCV website and the SFinge software. Bottom: Screen-shots of the Weka tool for machine learning and data mining.