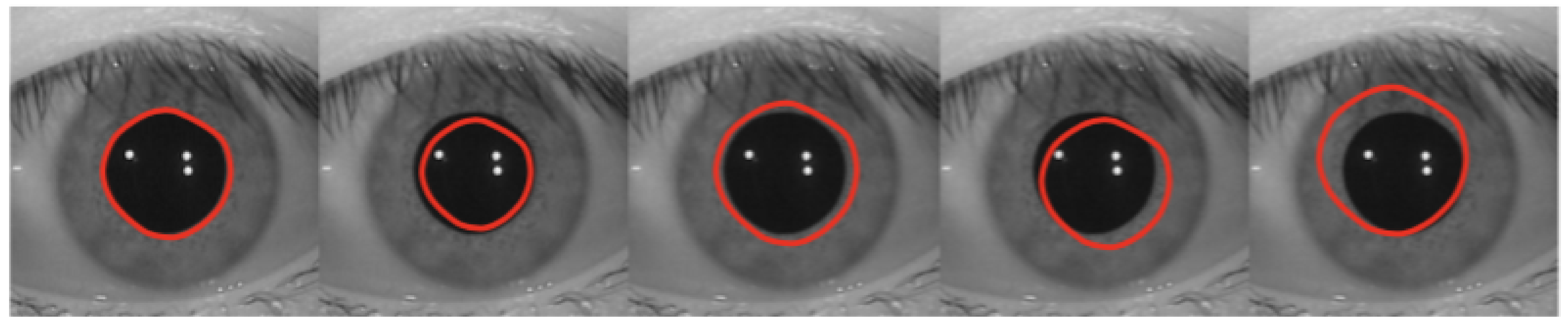

IRINA: Iris Recognition (even) in Inaccurately Segmented Data

Hugo Proença and João C. Neves
IT: Instituto de Telecomunicações, Portugal

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Contribution: Recognition of Badly-Segmented Iris Samples

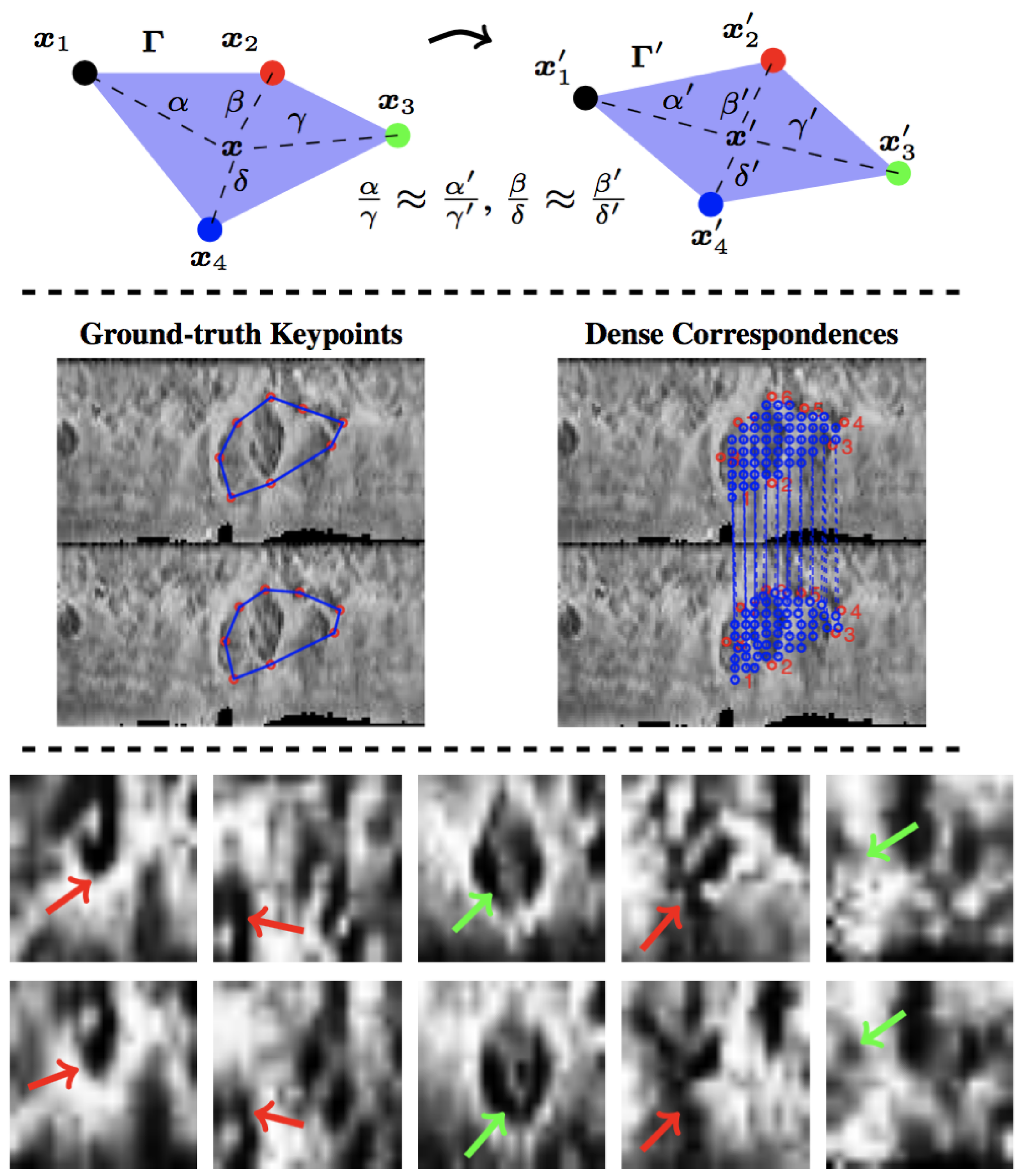
The effectiveness of current iris recognition systems depends on the accurate segmentation and parameterisation of the iris boundaries, as failures at this point misalign the coefficients of the biometric signatures. This paper describes **IRINA**, an algorithm for **I**ris **R**ecognition that is robust against **INA**ccurately segmented samples, which makes it a good candidate to work in poor-quality data. The process is based in the concept of "*corresponding*" patch between pairs of images, that is used to estimate the posterior probabilities that patches regard the same biological region, even in case of segmentation errors and non-linear texture deformations. Such information enables to infer a free-form deformation field (2D registration vectors) between images, whose first and second-order statistics provide effective biometric discriminating power.

Context

Despite de remarkable success of the deployed iris recognition systems, two major weaknesses subsist: 1) accurate segmentation and parameterization of the iris boundaries is required to image normalisation. As most of the iris encoding / matching strategies are phase-based, failures in segmentation lead to bit shifting in the biometric signatures, with a corresponding increase of false rejections; and 2) false rejections also increase in case of severely dilated / constricted pupils, which cause non-linear deformations in the iris texture that are only partially compensated by the normalisation phase. Pupil movements laterally pressure the iris, with some of the fibers folding underneath others and changing texture appearance.
Note that 1) varying lighting conditions change the levels of pupillary dilation; and 2) less constrained acquisition protocols reduce data quality and make hard to accurately parameterise the iris boundaries.

Key: Corresponding Patches

The concept of *corresponding* patches between pairs of iris images is the key to learn the typical non-linear deformations in the iris due to pupillary dilation / constriction and segmentation errors.



Top: based on a set of manually marked corresponding control points between two iris samples ($\boldsymbol{x}$ and $\boldsymbol{x}'$), two polygons ($\boldsymbol{\Gamma}$ and $\boldsymbol{\Gamma}'$) are defined. Next, for every point inside $\boldsymbol{\Gamma}$, the corresponding position in $\boldsymbol{\Gamma}'$ is found (middle row). Bottom: five pairs of corresponding iris patches, where non-linear deformations (red arrows), and vanishing / emerging regions (green arrows) inside each patch are evident.

References

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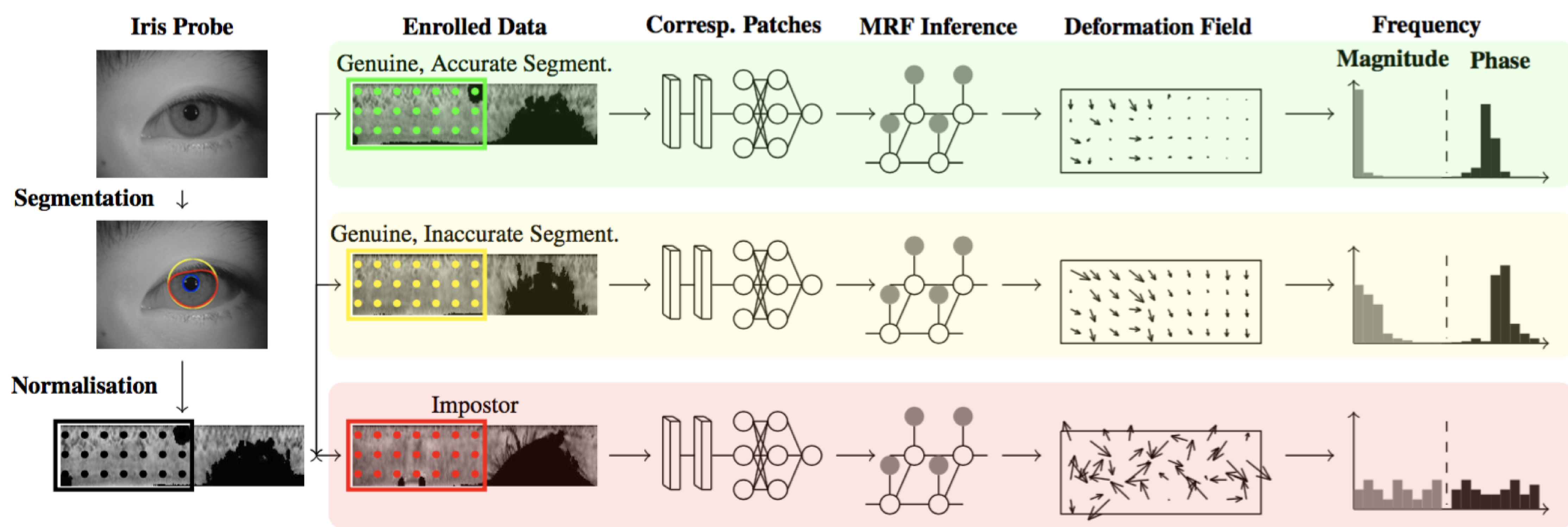
Processing Chain's Cohesive Perspective

IRINA's processing chain is divided into three main phases:

1. estimate the posterior probabilities that patches from two iris samples *correspond*, using a regression convolution neural network (CNN) that implicitly learned the typical iris texture deformations due to segmentation inaccuracies and pupillary dilations;
2. infer a free-form deformation field that registrates pairs of normalized samples. This is formulated using a discrete Markov random field (MRF), with unary costs provided by the responses of the CNN, and pairwise costs imposing smooth solutions that penalize local gradients of the deformation field. The loopy belief propagation (LBP) algorithm [3] is used to solve the image registration problem;
3. for biometric recognition, the key observation is that *genuine* deformation fields (between samples of the same subject) are composed of 2D vectors with phase and magnitude gradients substantially smaller than those of *impostors*. First and second-order statistics of these vectors provide the discriminating information for biometric recognition.



Results and Discussion

Our experiments show that IRINA not only achieves state-of-the-art performance in good quality data (compared to [1], [4] and [5]) , but also effectively handles severe segmentation errors and large differences in pupillary dilation / constriction. Also, IRINA almost keeps its performance up to segmentation inaccuracies of up to 12%, and then slightly decrease its results, which could even be attenuated if larger magnitudes in the deformation field are tolerated (yet, this would increase the number of labels in the MRF and the computational cost).
As current work, we are finding alternate strategies to reduce the computational cost of matching.