G26 Personal Identification by Morphometric Analyses of Retinal Vascular Pattern

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The goal of this presentation is to report the results of a biometric personal identification study conducted by comparing retinography samples obtained from different subjects

This presentation will impact the forensic community and/or humanity by demonstrating an interesting approach for personal identification for security environments

MATERIALS AND METHOD: A new method for personal identification by morphometric analysis of the retinal vascular pattern is presented.

In collaboration with the Ophthalmology Clinic of Bari University Hospital, two sets of color images of the right retinal fundus were acquired at two different times in 68 subjects, after instillation of mydriatic and using computerized fluorangiography. The system consists of a scanning laser camera connected to a computer, color monitor and operative software. This system enables acquisition of Megaplus 1.6 resolution images with 1534x1024 pixels that are immediately digitalized and stored on hard disk.

After making a quality selection of the images, they were submitted to morphometric analysis at the Electrotechnical and Electronics Department of Bari Polytechnic, using dedicated software.

Following the operative protocol, 5 reference points of the retinal vascular tree were identified: the origin of the superior temporal artery, the first bifurcation of the superior temporal artery, the origin of the superior temporal vein, the first bifurcation of the inferior temporal artery and the origin of the inferior temporal vein. These points were individuated and marked by the software on each image of the retinal tree. The program then automatically supplies the values for the absolute distances, the relative distances excluding reciprocals, the perimeter values and the areas of the triangles obtained by joining the points, as well as the independent variable consisting of the differences, albeit minimal, between similar irregular figures. Five numerical sets were thus obtained for each image.

Statistical comparison was made of the sets by linear regression, determining the correlation coefficient. Cross-analysis was made of each of the five numerical sets obtained from the 136 images (68 patients x 2), yielding 23120 comparisons (5 X 68 X 68) for heterologous correlations and 340 comparisons for homologous correlations (5 x 68).

RESULTS: Analyses showed that the *independent variable* and the *areas of the triangles* did not serve for identification purposes due to overlapping, the maximum values for the correlation coefficient in the heterologous comparisons being in the same range as those for the homologous comparisons in over 60% of the samples.

Instead, cross comparison of the correlation coefficients for the sets of *absolute distances, relative distances* and the *perimeters of the triangles* showed that they could potentially be useful, possibly in association with other analyses, for identification purposes.

There was no overlapping between the coefficients for the *absolute distances,* which yielded separate, distant dispersion curves for homologous and heterologous comparisons. Similarly, there was no overlapping for the triangle perimeters, which provided separate, albeit close clusters, for the correlation coefficients. There was only 1% overlap for the correlation coefficients for the *relative distances* (46 false positives/4620 comparisons).

The numerical results were:

- The correlation coefficient for autocorrelations for the *absolute distances* was between 0.999 and 0.992
- The correlation coefficient for heterocorrelations for the *absolute distances* was between 0.991 and 0.566
- The correlation coefficient for autocorrelations for the *triangle perimeters* was between 0.999 and 0.99299
- The correlation coefficient for heterocorrelations for the *triangle perimeters* was between 0.99293 and 0.56651
- The correlation coefficient for autocorrelations for the *relative distances* was between 0.99995 and 0.97876
- The correlation coefficient for heterocorrelations for the *relative distances* was between 0.99248 and 0.92452

Our results indicate that:

- The section point for the output of comparison of the *absolute distances* is 0.992; higher correlation coefficients indicate certain identification and lower values certain exclusion.
- The section point for the output of comparison of the *triangle perimeters* is 0.99299; higher correlation coefficients indicate certain identification and lower values certain exclusion.
- The section point for the output of comparison of the *relative distances* is 0.97876; higher correlation coefficients indicate positive identification, with a 1% risk of false positives.

Finally, it should be noted that the cases yielding false positives for comparison of the *relative distances* presented very negative values for the correlation coefficients of the *absolute distances* and the *triangle perimeters*. Thus, interpolating the results, it can be concluded that if comparison of the two retinal maps yields a higher correlation coefficient than the minimum threshold for autocorrelation of the absolute distances, relative distances and triangle perimeters, there is certain identification.

The method is currently being patented.

Biometric, Personal Identification, Retinal Vascular Pattern