A connectionist approach to using outer ear images for human recognition and identification

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Traditional image-based approaches to personal identification have almost exclusively employed front views of the individual's face [5], occasionally complemented by profile views [4]. Here, profile images were primarily used to match a template to the profile curve (from the chin to the top of the forehead) and additionally to help to locate those parts of the face (in the front view) that are considered to carry more discriminant information—such as the eyes and the lips.

This *obsession* for the front views of the face is justified by the extraordinarily developed capacity that humans show to recognize and identify an individual by means of a sheer image of his/her face. However, this does not necessarily mean that the face is the part of the human body that contains the largest quantity of discriminant data; an outstanding counterexample is the fingerprint. The human capacity to distinguish faces seems to be learned, as its efficiency is notably smaller when identifying faces from another race (the *other-race effect*).

In this paper, we propose the use of *auricle* images, i. e. images of the outer ear. An average person may not be used to employ the ear to identify an individual, unless it is so unusual that appeals even more than the eyes or the mouth (but even in this case it plays a secondary role). However, it has been shown to have more identification richness than the face or any other part of the human body—except for the own fingerprints—and not to change significantly from the moment in which the subject reaches adult age. The countless variations of the complex structure of the helix, lobe and different cavities and wrinkles, as well as its shape and size, make true the saying that "there aren't two equal ears," and in fact their importance has been known for a long time to both anatomists and the police: in the absence of fingerprints ears are often used in identification tasks [3].

From the point of view of image processing, ears have some advantages over faces:

- Their surface is smaller (approximately 1/25 to 1/20 of that of the face), which allows working with images of reduced spatial resolution.
- They have a more uniform distribution of colour, so that almost all information is conserved when converting the original image to grey scales (with faces, eye colour is lost, for instance).
- A face can change its appearance with the expression of the subject; the shape and appearance of an ear are fixed.

However, ears can be totally or partially occluded by hair or earrings; although occlusion can happen with faces, too, due to makeup, glasses, beard or hairstyle.

Two main approaches have been employed for the extraction of characteristics from a face image: by measuring geometric relations between predetermined points (lengths, angles, etc.), a process that presents difficulties to be carried out by a computer [5]; and directly using unsupervised feature extraction techniques, which look for statistically salient properties on the image data or *macrofeatures* [6]. We have opted for the latter possibility using neural networks in two stages, following the work of Fleming and Cottrell [2]: a first network, called *compression network*, is trained autoassociatively on the original data to extract, by principal component analysis, the required macrofeatures; these are inputted to a second perceptron-style network that performs the recognition/identification task itself. We repeated the whole process twice, first for face images and then for ear images [1]. In both cases a training set of 85 images (taken under the same lighting conditions and with the same resolution) from 17 different

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individuals was used, one with frontal views of the face, and another one with frontal views of the ear. The procedure described allows for a fair comparison between the discriminant power of face images and ear images through percentages of successfully recognised and/or identified individuals and other numerical measures. We show that the use of ear patterns provides a performance similar to that of face patterns, but with smaller images.

References

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