Automatic Face Recognition by 3-D Analysis

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1. MOTIVATION

Biometric measurements receive more and more interest for security applications where PINs and cards are less desired (due to loss or theft). In cooperative environments, speech and face modalities are well accepted by the individuals but they still suffer from limited performance. To achieve a sufficient level of reliability, the project M2VTS of the european ACTS program[1] combines several modalities (speech, profile, face, 3D).

A previous profile analysis[2] has shown the interest of dealing with geometrical (instead of grey-level) information for automatic face recognition. Let us mention the rather staticity of the underlying structure (forehead, nose, chin) and the little dependence on makeup or lighting conditions.

We hope to get new geometrical information from a 3-D description, especially where grey-level information lack (cheek, forehead, cheeks). The analysis will benefit from real 3-D measures (no scale or rotation influence). Depth information also helps segmenting the face from background objects.

3-D capture is usually expensive (scanner, LCD projector) and slow. We are more and more convinced that a simple structured light system can bring a lot of useful information for a low price. We have to prove the sufficient precision of the acquisition system with low-cost material and the potentials for face identification with 3-D info.

2. STRUCTURED LIGHT

The structured light system is composed of a normal camera and a common projector with an appropriate slide pattern. The camera and the projector are positioned to have their optical axis in a plane. Stripes parallel to the plane do not bring depth information. We thus use a slide with parallel lines perpendicular to the plane.

3-D positions are obtained from triangulation, knowing the coordinates of points in the image and their index in the superimposed stripe pattern. For this, stripe labelling must be possible. Wishing to work with (invisible) near IR light, we coded the stripe index into the (binary) thickness of neighbouring stripes.

For calibration, 7 parameters were identified, estimated from a ruler and refined by presenting a planar (regular) grid of points in different orientations, minimising the variance of the distances between those points.

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3. 3-D ANALYSIS

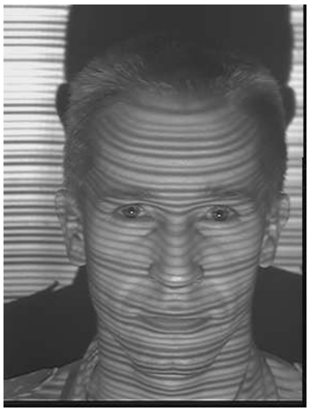
The points of the stripes are extracted (manually, until now) and converted to 3-D coordinates. A face is typically covered with 30 stripes separated by 0.5 cm. The discretization is inhomogeneous and we first decided to project stripes horizontally to have a balanced resolution on each side of the symmetry axis of the head.

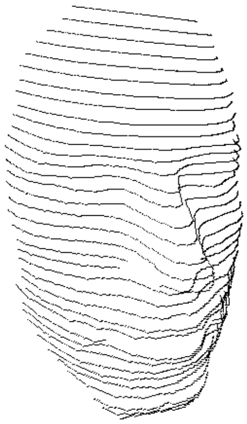
First attempts concerned data normalization, finding translation and orientation references. Although nose tip is a good initial reference and left and right parts are rather symmetric, no precise normalization could be achieved. Mainly, the information is not balanced (broken stripes, non-symmetric parts).

We thus turned to feature extraction, trying to get stable and discriminant characteristics, independent of rotation and translation. Features can be considered one at a time, allowing for a better control of their validity and of the program. They can be optimized and selected according to their quality (performance or speed).

4. FUTURE WORK

After this first evaluation of each step required for automatic 3-D face recognition, future work will concern slide quality, automatic stripe detection and labelling, and feature quality on a sufficiently large database. Infrared projection as well as software optimization should then bring the system to a practical solution which will have to be validated against illumination, pose and particularities (facial hair, spectacles).





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