HALMSTAD UNIVERSITY

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Doctoral thesis:

Compact orientation and frequency estimation with applications in biometrics

Biometrics on the orientation express

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Abstract:

Automatic feature extraction still remains a relevant image and signal processing problem even though both the field and technologies are developing rapidly. Images of low quality, where it is extremely difficult to reliably process image information automatically, are of special interest. To such images we can refer forensic fingerprints, which are left unintentionally on different surfaces and are contaminated by several of the most difficult noise types. For this reason, identification of fingerprints is mainly based on the visual skills of forensic examiners. We address the problem caused by low quality in fingerprints by connecting different sources of information together, yielding dense frequency and orientation maps in an iterative scheme. This scheme comprises smoothing of the original, but only along, ideally never across, the ridges. Reliable estimation of dense maps allows to introducing a continuous fingerprint ridge counting technique. In fingerprint scenario the collection of irrefutable tiny details, e.g. bifurcation of ridges, called minutiae, is used to tie the pattern of such points and their tangential directions to the finger producing the pattern. This limited feature set, location and direction of minutiae, is used in current AFIS systems, while fingerprint examiners use the extended set of features, including the image information between the points. With reasonably accurate estimations of dense frequency and orientation maps at hand, we have been able to propose a novel compact feature descriptor of arbitrary points. We have used these descriptors to show that the image information between minutiae can be extracted automatically and be valuable for identity establishment of forensic images even if the underlying images are noisy. We collect and compress the image information in the neighborhoods of the fine details, such as minutiae, to vectors, one per minutia, and use the vectors to "color" the minutiae. When matching two patterns (of minutiae) even the color of the minutia must match to conclude that they come from the same identity.

This feature development has been concentrated and tested on forensic fingerprint images. However, we have also studied an extension of its application area to other biometrics, periocular regions of faces. This allowed us to test the persistence of automatically extracted features across different types of images and image qualities, supporting its generalizability.