

Characteristic and Necessary Minutiae in Fingerprints

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Abstract: Fingerprints feature a ridge line pattern inducing an undirected orientation field (OF) which usually features some singularities. In fingerprint recognition, a fingerprint is usually reduced to a point pattern consisting of minutiae, i.e. points where the ridge lines end or fork. Whenever the OF features divergent ridge lines (e.g. near singularities), a nearly constant ridge frequency (RF) necessitates the generation of more ridge lines, originating at minutiae. We call these the necessary minutiae. A statistical analysis reveals that fingerprints feature additional minutiae which occur at rather arbitrary locations. We call these the random minutiae or, since they may convey fingerprint individuality beyond OF and RF, the characteristic minutiae.

In consequence, a minutiae point pattern is assumed to be a realization of the superposition of two stochastic point processes modelling the necessary and the characteristic minutiae, respectively. We propose a Bayesian approach using an MCMC-based minutiae separating algorithm (MiSeal) which allows for estimation of the underlying model parameters as well as the posterior probabilities of minutiae being characteristic. In a proof of concept, we provide evidence that for two different prints with similar OF the characteristic minutiae convey fingerprint individuality giving rise for improvements in matching algorithms for commercial and forensic applications using characteristicness of minutiae.

Keywords: Bayesian inference, biometrics, classification, Markov Chain Monte Carlo, spatial point processes.