

Algorithms for Contactless Fingerprint Recognition

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Abstract

Contactless fingerprint recognition offers advantages in hygiene and convenience, but its use is complicated by two main issues. First, the image capture process is uncontrolled, leading to variations in finger position and lighting. Second, the images must be compatible with existing contact-based fingerprint databases. This thesis provides a set of solutions to address these problems, covering every step from image capture to secure comparison.

The key contributions include new deep learning models, *FingerUNeSt++* and *TipSegNet*, that separate fingertips from the background with 99% accuracy. To ensure compatibility with contact-based systems, a processing pipeline was created to fix geometric distortions, which reduced comparison error rates by a relative 36.9%. To ensure data quality, this work developed *MCLFIQ*, a new quality score for mobile-captured fingerprints, and a tool to automatically detect image artifacts. Furthermore, the research outlines how to produce physical fingerprint models for standardized and repeatable testing.

For security-focused applications, a fingerprint comparison algorithm was adapted to run in a Multiparty Computation (MPC) framework. This enables a private remote identity check to be completed in approximately 17 seconds. In conclusion, this thesis presents a full, end-to-end pipeline that makes secure and interoperable contactless fingerprint recognition practical.