Performance Analysis of a *Hybrid Fingerprint* Extracted from Optical Coherence Tomography Fingertip Scans

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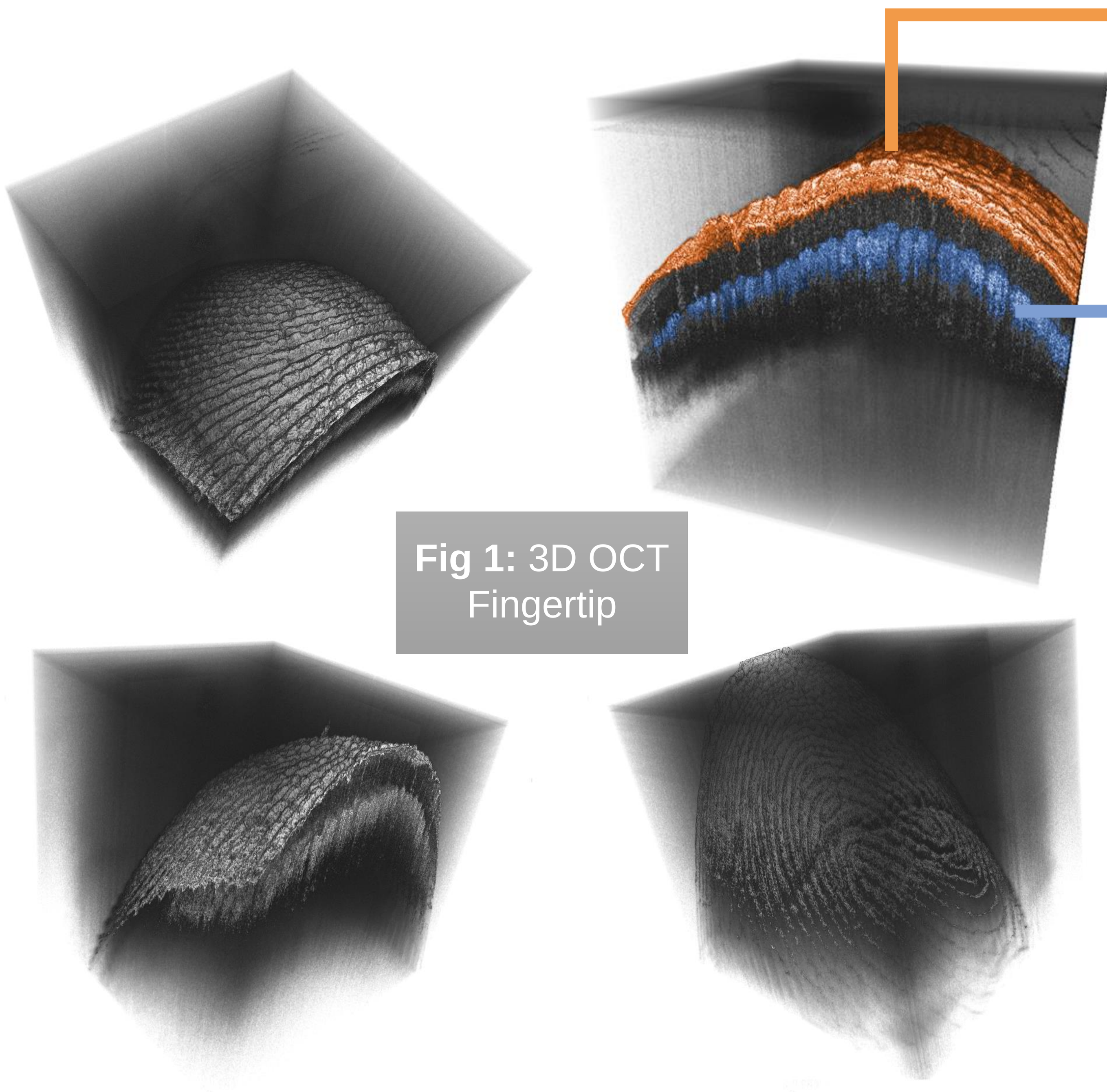


Fig 1: 3D OCT Fingertip

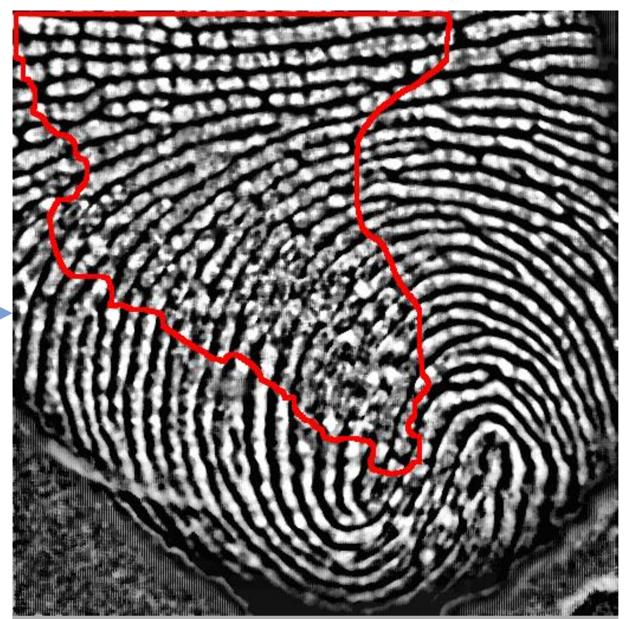


Fig 2: Internal Fingerprint

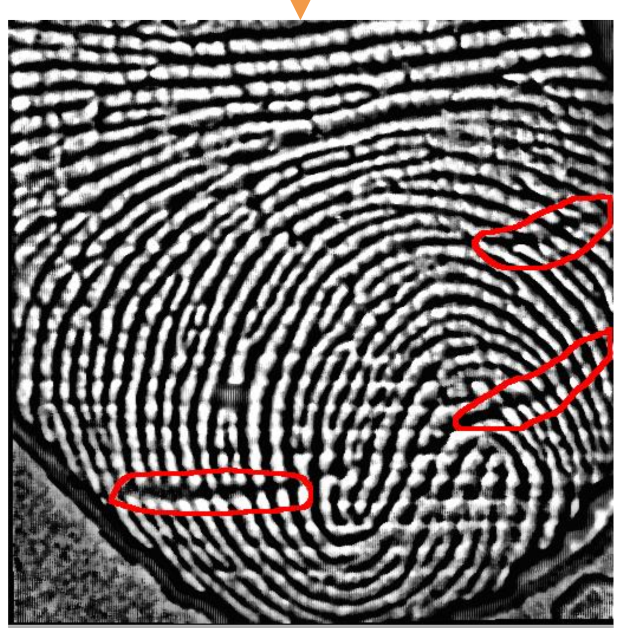


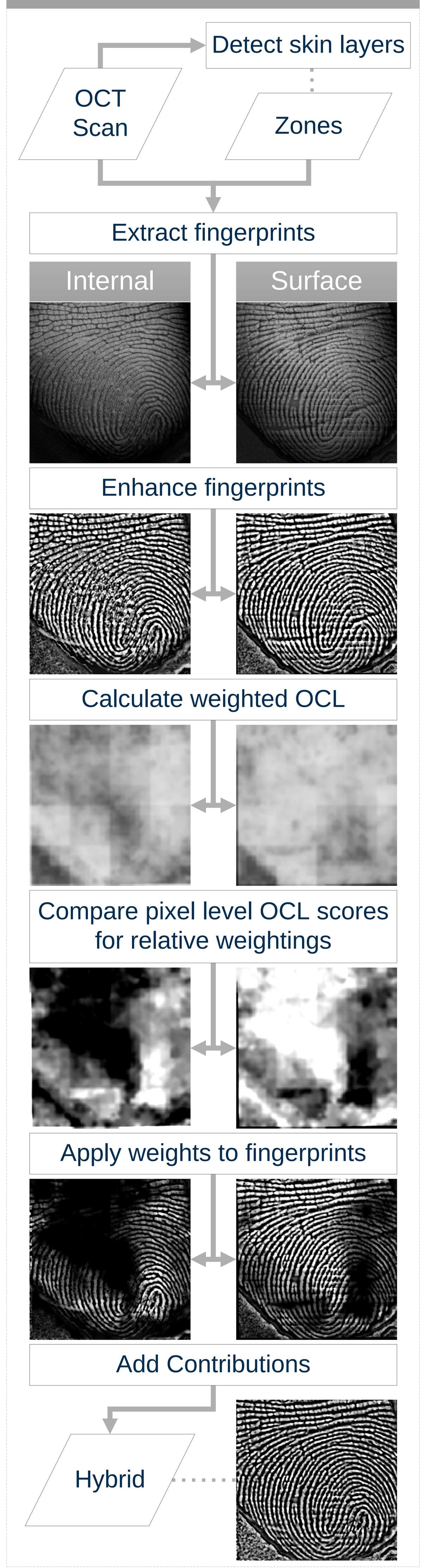
Fig 3: Surface Fingerprint

Fig 4: Internal Contributions

Fig 5: Surface Contributions

Fig 6: Hybrid Fingerprint

Fig 7: Algorithm overview



INTRODUCTION

Optical Coherence Tomography (OCT) is a biomedical imaging tool that has been successfully used to obtain fingerprints. *It provides a contactless, 3D, and internally penetrative representation of the fingertip skin*. An example of a fingertip scan obtained using OCT is illustrated **Fig 1**. It is advantageous because it solves several problems inherent in current technology.

DISTORTION, VARYING MOISTURE, & HYGIENE

OCT scans fingertips without the need for contact between the scanner and the fingertip. This solves the problem of elastic distortion in conventional 'slap' scan fingerprint acquisition devices, which is caused by pressure. Since it is contactless, it is also hygienic and residual fingerprints are not left on a scanner surface. Moreover, unlike current technology, it is invariant to moisture conditions.

SECURITY

OCT affords rich information for spoof-detection and is a high-security fingerprint acquisition solution [1].

FINGERPRINT DAMAGE & QUALITY

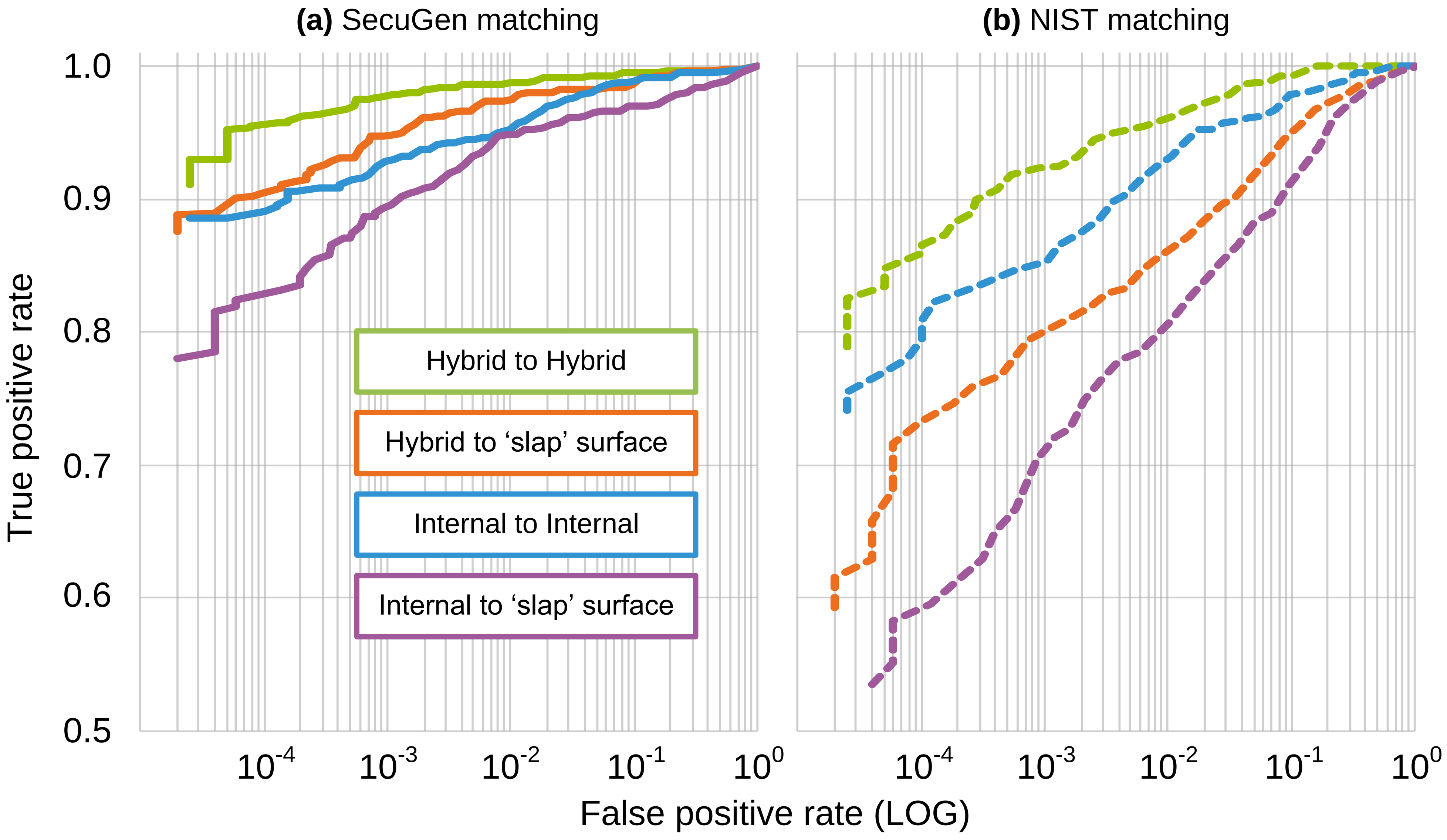
Two structurally identical fingerprints are present within each OCT scan: the Surface Fingerprint (**Fig 2**) and the Internal Fingerprint (**Fig 3**). The Internal Fingerprint is ±0.3*mm* below the surface and is therefore protected against damage and degradation. These two fingerprints are blended according to their local qualities. **Fig 4** and **Fig 5** show their contributions after quality estimation and comparison. The Hybrid Fingerprint (**Fig 6**) is the result of this blending. It possesses the best-quality components of both fingerprints.

THE HYBRID FINGERPRINT

The techniques used to extract both Internal and Surface Fingerprints, evaluate them on a per-pixel basis using their orientation certainty levels [2], and blending them to yield the Hybrid Fingerprint was pioneered in [3]. The significant optimisations are demonstrated in **Fig 2** to **6**, while **Fig 7** gives an overview of the process. Note the presence of wrinkles on the Surface Fingerprint (**Fig 3** regions of interest) but not on the Internal Fingerprint (**Fig 2**). The blending procedure compares the quality of these regions in both fingerprints and masks out the poorer quality regions. The wrinkles in **Fig 3** are masked out as seen in **Fig 5**. The poorer contrast region (**Fig 2**, region of interest) in the Internal Fingerprint is also masked out in **Fig 4**. *The Hybrid Fingerprint has superior contrast and is not influenced by any wrinkles or damage that may be present on the skin surface.*

The Receiver Operating Curves for fingerprint matching using commercially available software are shown in **Fig 8**. SecuGen was used for (a) and NIST for (b). Comparisons were made on a database of 282 OCT Fingertip scans. Hybrid Fingerprints were compared against other Hybrid Fingerprints (*equal error rate of 1.25%*) and against 'slap' scans obtained from a conventional contact-based fingerprint acquisition device (*equal error rate of 1.95%*). The same tests were performed on the Internal Fingerprint with the same data.

Fig 8: Receiver Operating Curves for fingerprint matching (LOG scale)



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3. L. N. Darlow and J. Connan. Efficient internal and surface fingerprint extraction and blending using optical coherence tomography. *Applied Optics*, 54(31):9258-9268, 2015.