FBI-CERTIFIED

CONTACTLESS-3D FINGERPRINT SCANNER

IDLOOP'S CFS® FLATS

What is CFS® flats?

CFS flats is a high-quality 3D-contactless fingerprint scanner (see Figure 1). CFS flats belongs to IDloop's CFS® family of devices, a group of devices that use **bluelynes® technology** to capture 3D-scans.

CFS flats captures flat fingerprints from one or multiple fingers. Instead of requiring the user to touch a surface to scan the ridges and valleys of their fingerprint, CFS flats enables the users' fingerprints to be captured without coming into any surface contact.

CFS flats scans both the fine and coarse structure of the fingers in full 3D, and then uses an unwrapping algorithm to transfer the 3D data into a 2D gray-scale image. This allows the scan to be compared with entries in standard 2D fingerprint databases.

Figure 1: 3D-contactless fingerprint capture with CFS flats.

The Technology Behind CFS flats

CFS flats uses structured blue light for 3D reconstruction (see Figure 2).[1] A known pattern is projected on and deformed by the surface structure of the finger. By imaging the deformed pattern with a camera, the 3D surface shape can be reconstructed via triangulation. An unwrapping algorithm transforms the 3D fingerprint scan to a 2D image, thereby providing important compatibility with today's infrastructure of contact-based 2D fingerprint databases. Therefore, not only can CFS flats be used for verification, but also for enrolment in these 2D fingerprint databases.

The 3D contactless fingerprint scanner CFS flats does not just take a picture of the fingerprint, but instead takes a full 3D image of the fingerprint, creating a 3D point cloud of the surface of the fingers. CFS flats takes up to eight million data points per scan, 13 point-clouds per second, achieves a micron-scale depth resolution, and outputs data in the government standard fingerprint quality (e.g. 500ppi resolution).

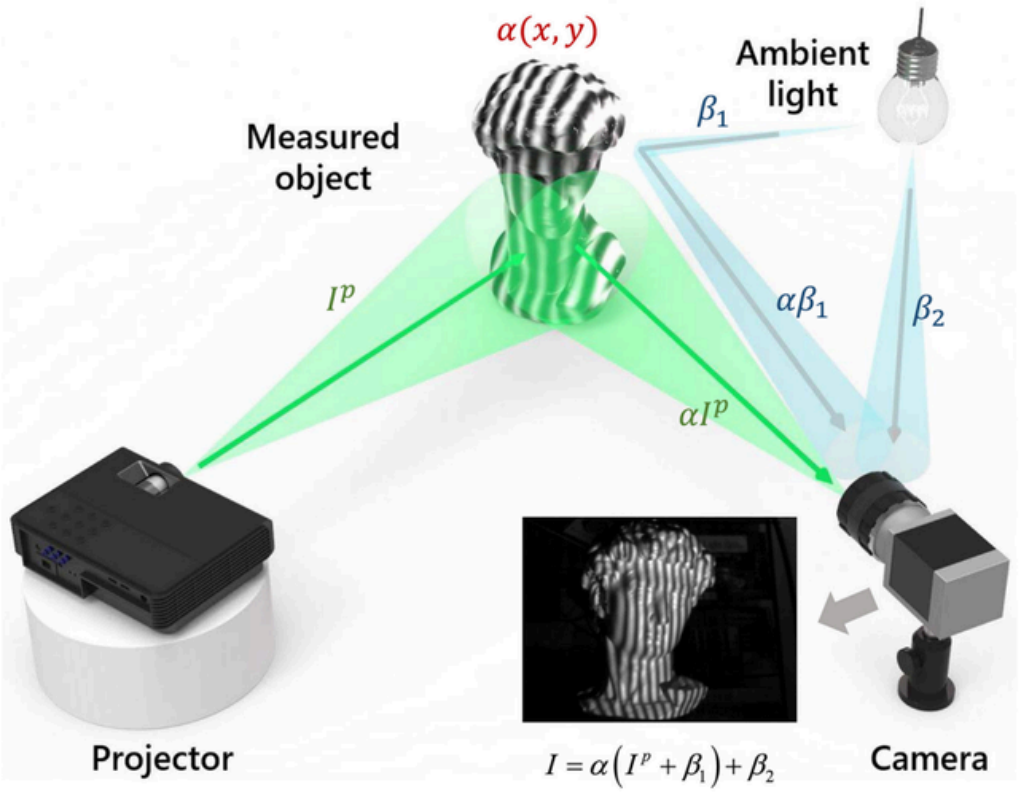

Figure 2: Illustration of fringe projection, reflection, and acquisition process.

[1] Zuo, C. et al. 2018. Phase shifting algorithms for fringe projection profilometry: A review. 109: 23-59.

A Little About Fingerprints

Records show that fingerprints may have been used to authenticate a person's identity for over a thousand years. While early finger impressions were made in clay (see Figure 3)[2], it later became the practice to collect fingerprint impressions in ink and impress the pattern onto a paper card.[3]

In the 1960s, the first contact-based optical fingerprint scanners were developed[4] and quickly became the norm. With this technology, the fingers are placed on the surface of a prism and light is projected through the prism onto the surface of the skin.

Figure 3: Ancient fingerprints preserved in clay

The fingerprint areas without contact (the valleys) reflect 100% of the light (total internal reflection), creating the lighter portion of the digital picture. The fingerprint areas with contact (the ridges) to the prism reflect only a portion of the light, therefore creating the darker portions of the image.

With the digitalization of fingerprint acquisition, fingerprint databases exploded in use, and in size. Now there are billions of 2D-digital fingerprint images stored in multiple databases around the world for comparison and use in identification and verification.[5-7]

[2] Cummins, H. 1942. Ancient Finger Prints in Clay. 32 J. Crim. L. & Criminology 468 (1941-1942).
[3] Sonderegger, B., Peter, M. U. 2012. Der Fingerabdruck (1913-2013): 100 Jahre im Dienst der Eidgenossenschaft, Schweizerische Eidgenossenschaft.
[4] Harrick, N. J. 1962/63. Fingerprinting via Total Internal Reflection. Colour Separation 9(24): 271-274.
[5] Unique Identification Authority of India (UIDAI), Government of India.
[6]Automated Biometric Identification System (IDENT), U.S. Department of Homeland Security. U.S. Department of Homeland Security.
[7] Tsianos, V. S. & Kuster, B. 2016. Eurodac in Times of Bigness: The Power of Big Data within the Emerging European IT Agency. Journal of Borderlands Studies, 31(2):235-249.

Why is 3D- Contactless Better?

With the size of 2D digital fingerprint databases, any new fingerprint acquisition method must be compatible with those database entries. What, then, are the advantages of 3D-contactless fingerprints from CFS flats over traditional 2D-images?

CONTACTLESS vs CONTACT-BASED

One of the most beneficial aspects of CFS flats is that it is completely contactless. A user can have their ten fingerprints captured without once contacting the surface of the device. This contactless aspect protects the user from any bacteria, viruses and/or chemicals that might have been left on the surface of the device by previous users. In addition, no latent prints are left on the scanner from previous users, which can pose security problems due to false matching. The contactless workflow also assists the operator from needing to clean the surface between uses, decreasing the cost of operating materials, and speeding up the time of acquisition. Normal wear-and-tear and device damage also is drastically reduced simply because the device does not need to be touched. Common contact-based scanner challenges, such as scratched surfaces, become obsolete.

CONTACTLESS: 3D vs TAKING A 2D PICTURE

However, not all contactless fingerprint scanning methods are created equal; there are multiple ways to capture a fingerprint without touching a surface. Smartphone cameras simply take a 2D picture of the finger to collect fingerprint data. However, this technique has multiple drawbacks, especially if the resulting fingerprint needs to be matched to an existing database of 2D legacy fingerprints captured by a contact-based scanner.

- *SCALING*

The scaling factor is dependent on the distance between hand and camera, and the specifics of the camera itself. When a simple picture is taken, this distance information is unknown in the ensuing contactless fingerprint image. The result is that fingerprint data taken with a camera does not match well with fingerprint data taken with a contact-based scanner (poor contactless-to-contact-based matching). Furthermore, fingerprint data taken with a camera does not match well with itself, if, for instance, a picture of the same hand is taken multiple times (poor contactless-to-contactless matching). Most classical matchers (algorithms built to compare fingerprints) evaluate distance features (the distance between valleys and ridges on the surface structure) of the fingerprint, making an accurate measurement of hand size vital for matching comparisons.

- *PERSPECTIVE DISTORTION*

2D pictures are inherently affected by perspective distortion - twice. First, the finger's relative position and rotation, with respect to the camera, strongly influences local features. In addition, fingers are also rounded, leading to an intrinsic distortion of the papillary (ridges and valleys) line structure on the edges of the finger.

- *LIGHT-SOURCE-DEPENDENCY*

With 2D pictures, the image details of the ridges and valleys of the fingerprint depend strongly on the position of the light source (both ambient light and light from the camera), as the ridge structures produce shadows in the valley regions.

- *POLARITY INVERSION*

When a 2D photograph is taken, typically the ridges appear brighter than the valleys. But there are also cases where this contrast is reversed (depending on skin conditions and lighting). This inadvertent polarity inversion produces false biometric information and significantly lowers the identification rate.

CONTACTLESS 3D vs “2.5D”

A more advanced technique for contactless fingerprint scanning, often referred to as 2.5D imaging, scans the macroscopic shape of the finger in 3D and the fine structure is deduced by a texture image from a high-resolution 2D camera[8]. The 3D information might come from photogrammetric measurements, a stereoscopic camera, or a structured light scanner.

This 2.5D imaging essentially wraps the 2D textured image on a macroscopic 3D structure to create the image. The combination of this coarse 3D information with a suitable algorithm for unwrapping the texture image resolves the ambiguity in scaling and perspective distortions (see points 1 and 2 above). However, the effects of the light position and polarity inversion (see points 3 and 4 above) remain problematic.

CONTACTLESS TRUE 3D

In contrast to both 2D and 2.5D techniques, CFS flats completely scans the surface of the finger in microscopic 3D. This method eliminates all four issues presented above: scaling problems, perspective distortion, light position effects and polarity inversion.

Since CFS flats scans the surface of the finger, it has an absolute value for the position of the hand, and therefore, an accurate scale for the size of the fingers and its ridges and valleys.

With 3D scanning, perspective distortion is also not a factor - the 3D-to-2D unwrapping algorithm cancels out the distortion. The 3D scan removes any light source dependency, and since there is no photograph, polarity ambiguities do not come into play. The micron-scale depth resolution allows for a clear distinction between ridges and valleys (see Table on the next page).

[8] Paar, G. et al. 2008. Photogrammetric fingerprint unwrapping. J. App. Geodesy. 2(1): 13-20.

Table: Technology solutions for errors introduced by contactless imaging methods in regard to compatibility with traditional contact-based fingerprint images

	2D	2.5D	3D
Scaling		✓	✓
Perspective Distortion		✓	✓
Light-Source-Dependency			✓
Polarity Inversion			✓

CFS flats: A Versatile Solution Across Industries

The fast operating speed and high accuracy of CFS flats makes it ideal for use in areas of high throughput, such as border crossings and airports. CFS flats' high accuracy also makes it appropriate for use in the high security industry, in criminal investigations and by law enforcement.

CFS flats is convenient to use and durable, making it an obvious choice in areas of repeated use, such as access control to secure buildings and other protected areas. Additionally, where there is a higher-than-average chance of contagions being transferred by surface contact (i.e. hospitals), CFS flats is a safe choice to protect the user.

The 3D-contactless fingerprint scanner, CFS flats, is a revolutionary product in contactless fingerprint scanners in the biometric world. It combines the accuracy and security of contact-based fingerprints with the convenience and hygiene of contactless scanning, making it an ideal choice for biometric identification in many situations.

IDloop GmbH

Moritz-von-Rohr-Str. 1a
07745 Jena | Germany

+49 3641 554050
contact@idloop.com
www.IDloop.com