HW-Accelerator for Sub-Pixel FP Reconstruction

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Fingerprints are the favorite biometrics for user authentication. Automatic fingerprint recognition systems represent more than 66% of the worldwide biometrics market. With the principle goal to reduce cost and energy consumption, the sweep fingerprint sensor technique has been adopted by various sensor-manufacturers. An additional benefit of sweep sensors is their self-cleaning feature avoiding theft from latent fingerprints. Sliding a finger over a sweep sensor generally shows not uniform speed, pressure, and adhesion during the capturing phase, which complicates the reconstruction problem.

Motivation

We consider two-line sweep sensors for which the reconstruction algorithms are proprietary and not published. These algorithms run in dedicated high performance, power hungry companion chips, which are not suitable for our target low-cost, low-power, portable applications that we realize with hardware algorithms.

Sub-pixel Shift Estimator

Sweep fingerprint sensors capture with constant sample-rate consecutive frames (CFs) from a sweeping finger. The sweep speed varies in time, and, therefore, the displacements Δs between each two CFs vary as well. Our algorithm estimates the sequence of Δs based on an ad-hoc formula involving correlation that indicates the similarity of two sensor columns.

The displacement estimation formula has been developed by a careful analysis of the sub-pixel image reconstruction problem.

$$\Delta s[n] \approx (CC_r[n] - CC_s[n]) / (CC_l[n] + CC_r[n] - 2 \cdot CC_s[n])$$

Where $CC_s[n]$ is the correlation between the left and right pixel column of frame number *n;* $CC_l[n]$ gives the correlation between the left pixel column of frame *n* and its follower frame *n+1;* finally, $CC_r[n]$ is the counterpart for the right pixel column. Figure 1 shows simulation results obtained by numerous fingerprint capturing- and reconstruction experiments. The bias of the algorithm is reduced in a two step process.

Accuracy and Robustness Analysis

We have analyzed the accuracy and the robustness of our sub-pixel fingerprint reconstruction algorithm using various synthetic CFs. These synthetic CFs, all base on real fingerprints, serving as the mother templates of our synthetic slice model. The goal of the experiment is to demonstrate the robustness of our approach by analyzing: Global stretching and worst-case local stretching. Figure 2 illustrates the global as well as the local stretching effect. The standard deviation of these experiment is 5.8 pixels.

Further Reading

For more details, read our IEEE peer-reviewed paper *"A Subpixel-Based Fingerprint Reconstruction Algorithm",* published at NEWCAS2012, Montreal, Canada.

Andreas Habegger

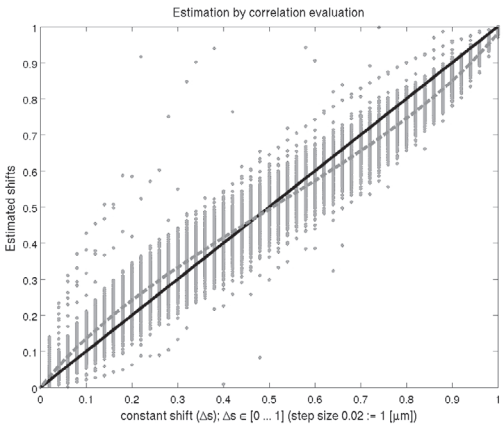

Fig. 1: Performance analysis of our estimation algorithm over the full speed range for constant sweep speeds.

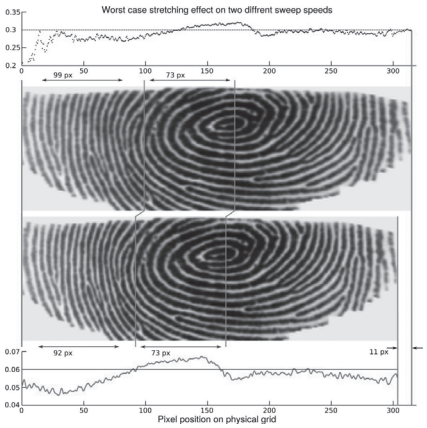

Fig. 2 : Influence of inaccurate estimations; The global stretching for the sweep speeds 0.06 and 0.3 pixels per frame, respectively, is 11 pixels.