Biometric Standards, Performance, and Assurance Laboratory

Department of Industrial Technology
Purdue University

Fingerprint Sensor Degradation

C. A. Hernandez, S.J. Elliott, Ph.D.

Department of Industrial Technology, School of Technology, Purdue University, West Lafayette, IN 47907

Abstract

This study will evaluate failure rates and image quality among capacitance fingerprint sensors. Through the analysis of fingerprints collected using two separate capacitance sensor chips at Purdue University; the average number of images a sensor can produce with a quality factor greater than 0.6 will be determined. This will aid in the development of a standard life cycle for a given sensor and aid users in making decisions regarding product feasibility and return on investment

Research Problem

Wayman and Mansfield (2002) have provided a biometric model that all biometric devices follow. Figure 1 is the visual representation of the model and standard.

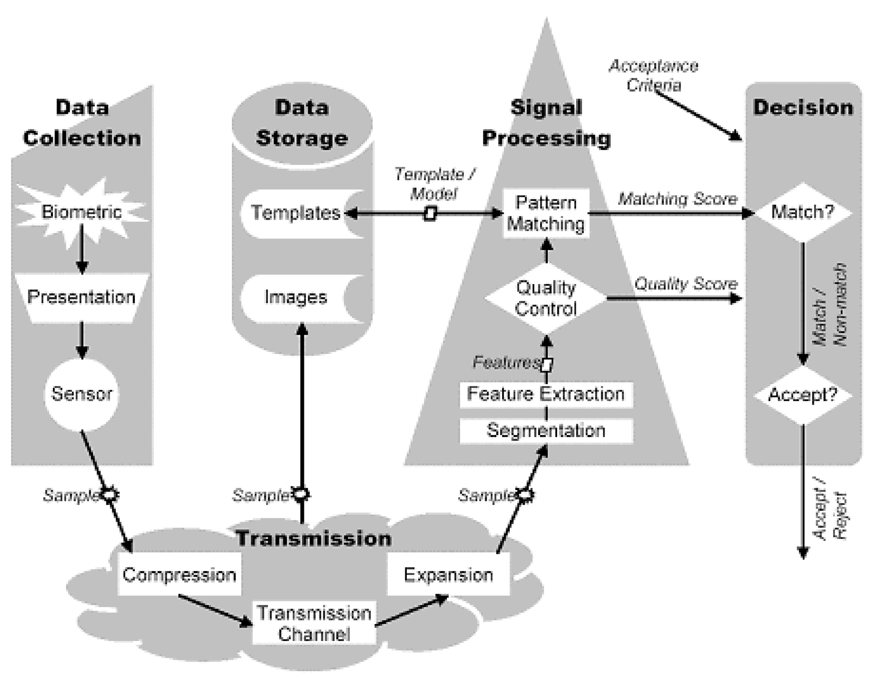

Figure 1. Diagram of General Biometric Model (Mansfield & Wayman, 2002).

This study deals with data collection and signal processing part of the model, specifically the sensor and quality control issues. If the life span and level of quality that a sensor will provide can be predicted, industry professionals can better recommend devices for a given application.

In 2003, fingerprint based devices will account for 52.0% of the total biometric market share that is expected to reach $928 million that same year. Growth for this market is a result of not only wide scale implementation, but with the adoption of biometric standards (International Biometric Group, 2003). By examining the degradation of image quality of two separate capacitance sensor chips, one failed; the other continued to operate within the manufacturer's tolerance levels used during a study at Purdue University. The resulting image quality graphs will be used to examine when the sensor failed and provide research for development of fingerprint device standards.

Research Significance

The significance of this problem rests on three premises. First, given enough time and usage, most electronic devices will fail to perform as originally intended. Knowing the average lifespan of a fingerprint device allows the user to make decisions regarding product feasibility and return on investment (Podio, 2001).

Secondly, because the biometrics industry is relatively new and is growing very quickly, it is important that more information is gathered on device performance and industry standards be established (Podio, 2001). The need for fingerprinting standards was highlighted in the FCV2000: Fingerprint Verification Competition: "The lack of standards has unavoidably led to the dissemination of confusing, incomparable, and irreproducible results, sometimes embedded in research papers and sometimes enriching the commercial claims of marketing brochures" (Cappelli, Jain, Maio, 2002, p. 402). The National Institute of Standards and Technology believes that standards will also improve the performance of biometric systems (M1/03-0353, 2003).

The quality of the image presented to a device is crucial to a high operating performance for a biometric system (Podio, 2001). Bolle, Jain, Pankanti echo this by stating that image quality is key because the ultimate objective of the sensor is to achieve the best image by which to produce a correct match result (1999). "A poor quality fingerprint image is a result of a genuine finger that is captured with noise (polluted fingerprint image) or insufficient information (partial fingerprint image)" (Lim, Jiang, Yau, 2002, p. 469). An invalid image is one that is captured with residue, stain or watermark on the sensor (Lim, Jiang, Yau, 2002). When addressing image quality, the literature produced three areas that must be addressed: the user, device and image quality standards.

Experimental Design

ASSUMPTIONS

- All users become habituated with respect to device usage at the same rate over the course of data collection.
- There were no physical or hidden electronic problems with the sensor when the study began.
- It is assumed that all other capacitance chips will react in a similar fashion as the test device.
- It is assumed that device parameters and image collection is uniform for all users.

DELIMITIATIONS

This study will not look at the number of attempts that were required for the device to obtain an image.
A quality factor used by WSQ Imager is used to assess image quality.
The results of this study will only be applied to capacitance fingerprint technology.

HYPOTHESIS

- There is not statistically significant difference in image quality over uses with a capacitance fingerprint scanner.
- There is no statistically significant difference between the two fingerprint scanners with respect to image quality.

Preliminary Research Results

The capture device is critical to acquiring a quality image and is also very important for reducing the number of false accepts and false rejects of a biometric system. The device should be constructed in such a way so as to provide a user-friendly interface and provide the user with the best opportunity to consistently present a quality image (Jain, Pankanti, Prabhakar, 2002). Any variation in the image capture process will result in lower or higher quality images and decreased performance of the system (Bolle, Hong, Jain, Pankanti, 1997). To keep these variations to a minimum, there are device standards. The common standard for fingerprint images is 500 dpi, with some devices using 250 dpi. The image area range is defined as 0.5 in_2 to 1.25 in_2, with a common standard of 1.00 in_2 (Bolle, Jain, Pankanti, 1999).

Figures 2-5 are examples of the enrollment and three verifications images taken from a single user over the lifetime of the original study. Each user enrolled their biometric on the first session and over the span of a month verified in each of the three resulting visits. The increase of grey noise on the outside of the images shows how the device begins to fail.

Figure 2. Enrollment 1 with no sensor noise

Figure 3. First Verification with increased sensor noise

Figure 4. Second Verification with increased sensor noise

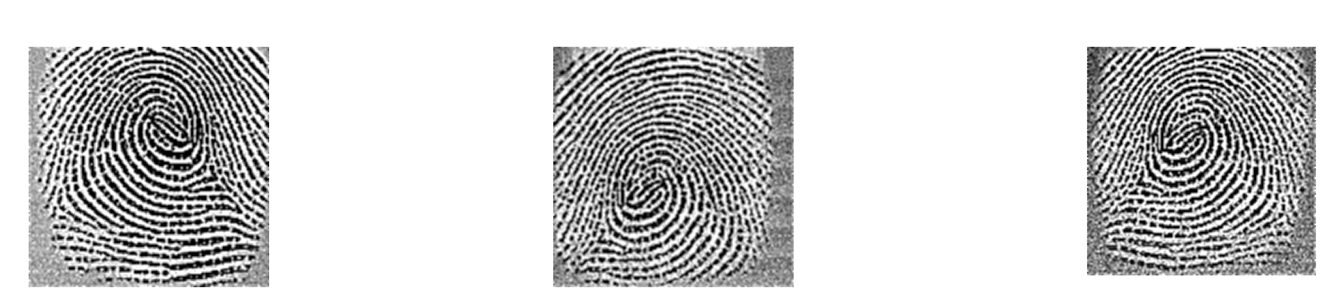

Figure 5. Third Verification with variation of increased sensor noise

PURDUE UNIVERSITY

CERIAS®

Discovery Park
e-Enterprise Center