

## Security at Your Fingertips

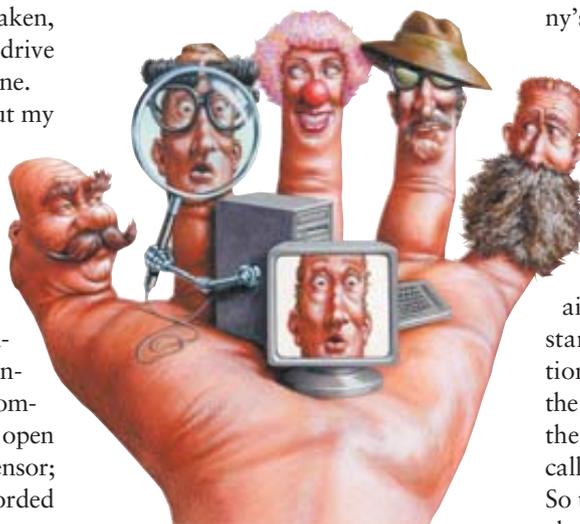
FINGERPRINT SENSORS CAN GUARD YOUR COMPUTER DATA BY MARK ALPERT

Like many children of the 1960s, I have long entertained James Bond fantasies. While walking to work in midtown Manhattan, I often imagine myself as an agent for the British intelligence service, hunting down Dr. No or Goldfinger or Blofeld as the silhouettes of beautiful women dance languidly in the background. I drink vodka martinis (shaken, not stirred), and I would certainly drive an Aston Martin if I could afford one.

I recently got a chance to act out my spy dreams after I learned about a new class of fingerprint security systems that can work with your PC or laptop. These relatively inexpensive devices can protect your own top-secret electronic files by recording your fingerprint—any finger or thumb will do—on a small sensor attached by a USB line to your computer. Thereafter anyone seeking to open the files must place a finger on the sensor; if the print does not match the recorded data, access is denied. Fingerprint authentication can also provide an extra level of security when you're conducting transactions on the Internet. And the technology can stop hackers from breaking into corporate or government networks, because it's a lot harder to steal a finger than a password.

For years, researchers have been tinkering with identification systems that could recognize a user's voice, face, handwriting, or patterns in the iris and retina. (The field is known as biometrics.) Fingerprint identification is the simplest method because every print has a unique set of clearly defined markers: the coordinates of the minutiae points, the places

where the epidermal ridges begin and end. These points are what the police use to match the fingerprints left at a crime scene with those of a suspect [see "No Two Alike," by Mark Fischetti, Working Knowledge; SCIENTIFIC AMERICAN, March 2003].



**IF DIGITAL IMPERSONATORS** are trying to swipe your electronic files or break into your computer network, you may want to enhance your security by installing a fingerprint verification system. The software records your fingerprint and allows you to use it as a password for files, networks or online transactions.

In some ways, though, a fingerprint-verification device for PC users must be more fault-tolerant than the systems devised for law-enforcement agencies. Police officers can make sure they get readable prints by carefully rolling a suspect's fingers on a traditional ink card or an electronic scanner. In contrast, most PC

users won't be so meticulous; a commercial system must be able to verify their prints even if their fingers are positioned sloppily or speckled with glazed sugar.

The security system developed by DigitalPersona, a firm based in Redwood City, Calif., is designed to recognize even the muddiest fingerprints. The company's U.are.U 4000 sensor is smaller than a deck of cards and has an oval plastic window on which you place your finger. As your digit nears the window, six LEDs in the device shine light against the inside surface of the plastic. The light is angled in such a way that it is totally reflected if there is nothing but air above the window. But if a substance with a higher index of refraction—such as skin—is pressed against the window, the light will be absorbed at the points of contact, a phenomenon called frustrated total internal reflection. So the reflected light, which is read by a charge-coupled device inside the sensor, bears the pattern of the fingerprint.

The sensor sends the resulting image (encrypted, of course) to your computer's microprocessor. Using a variety of complex algorithms, the DigitalPersona software determines the coordinates of up to 70 minutiae points and packages the data in a 300-byte template. The system compares these templates to match fingerprints; the fingerprint images themselves are erased to prevent any possibility of theft. Because each template also contains data about the angles of the fingerprint ridges, the software is able to make a match even when the orientation of the

finger is quite different from its placement when the print was originally recorded. Other algorithms analyze the overall ridge flow—the oddly beautiful loops, whorls and deltas—to decipher any smudgy parts of the image. The entire process takes about 200 milliseconds.

DigitalPersona grew out of an undergraduate project at the California Institute of Technology. Vance Bjorn, the company's co-founder, developed the key fingerprint-recognition algorithms in the early 1990s with fellow Caltech student Serge Belongie, who is now an assistant professor at the University of California at San Diego. Vance came to my office to show me DigitalPersona's latest products, letting me register one of my fingerprints using a U.are.U 4000 sensor attached to his laptop. I placed my right index finger on the sensor's glowing red window four times in quick succession so the system could create an accurate record. After that point, it recognized my right index finger every time I put it on the sensor and consistently rejected all other fingers and thumbs. The system's design goal is a one-in-50,000 chance of accepting the wrong fingerprint and a one-in-100 chance of rejecting the correct one.

Vance then showed me an even smaller sensor, dubbed the U.are.U Firefly, which is tiny enough to be incorporated into the body of a laptop or PDA. The user runs his or her finger over a half-inch-long transparent rod that rotates like a rolling pin. As the rod turns, LED light bounces off different parts of the fingertip, creating a series of linear images that are stitched together to form the fingerprint. When not needed for fingerprint recognition, the rod can be used to scroll pages up and down the screen.

As I tried out the device, I cried, "This is so cool!" rather loudly. This outburst attracted the attention of my colleague George Musser, who rushed into my office to see what all the fuss was about. George insisted on recording his own fingerprint on Vance's laptop. (The system allows several users to share a

computer yet keep their files private.) Then George, who is a preternaturally inquisitive character, tried to figure out a way to fool the system. First he made a copy of his fingerprint using a piece of Scotch tape and ran the imprint over the sensor.

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## TECHNICALITIES



But because the device uses several LEDs shining in different directions, it obtains a three-dimensional image of a fingerprint and hence can't be fooled by a two-dimensional copy.

George, however, was undeterred. He retreated to his office and returned a few seconds later with a piece of orange putty from one of the toys on his windowsill. He molded the putty to his finger to create a three-dimensional copy of his fingerprint and ran it over the sensor. Interestingly, James Bond used a similar technique in the 1971 movie *Diamonds Are Forever*; Agent 007 managed to pose as one of Blofeld's henchmen by wearing a set of false fingerprints fashioned by Q, the gadget wizard of the Bond films. George's attempt, alas, was not as successful. Vance conceded that an expertly

**REFLECTED LIGHT** reads fingerprint patterns in DigitalPersona's U.are.U 4000 optical sensor.

constructed mold might be able to trick the sensor, but making the mold would require the cooperation of the individual being impersonated.

The growing concerns about identity theft may give a boost to fingerprint-verification technology. If you do your banking or stock trading online, for example, you may feel an extra degree of comfort from knowing that nobody can

log on to your account without submitting the proper fingerprint. And the devices are not too hard on the wallet. DigitalPersona's U.are.U Personal system, which is meant for home or office use, retails for less than \$100. Other companies offer similar products in the \$100 to \$200 range: Biolink Technologies International sells the U-Match Mouse, which has an embedded fingerprint reader, and Identix has the Bio-Touch PC card, an optical reader that can slip into your laptop's card slot.

Beyond the potential advantages of enhanced security, one must also consider the sheer entertainment value of these products. It's fun to seal all your electronic documents from prying eyes, even if your hard drive contains nothing that is classified. ■

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