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How Paper's Unique Textures Can Foil Counterfeiters

Researchers in the U.K. say they've delved below the surface of the page to develop a cheap, tough authentication method

An overview of the equipment and capturing procedure developed by scientists in the U.K. for fingerprinting a paper sheet, May 21, Newcastle University, Newcastle upon Tyne, U.K. PHOTO: EHSAN TOREINI

By Daniel Akst

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Casual appearances to the contrary, every sheet of paper is unique—even before anyone writes on it. This has long drawn the attention of scientists working to thwart counterfeiters.

Now researchers at Britain's Newcastle University and University of York have delved below the surface of the page to develop an authentication method that they say is cheap and tough to crack. Previous research has exploited surface variations in paper for similar aims, but the scientists in Britain went deeper because patterns within the paper are more complex than those on its surface—and harder to tamper with.

Sheets of paper are unique because of the way they are manufactured. Paper is typically made by pressing wood particles together (often along with whitening agents, dyes and coatings), a process that produces individual pages containing random and complex patterns. Those patterns, the scientists write, "are embedded within the bonded structure of the paper and hence are relatively well-protected against manual handling of paper."

For the new authentication technique to work, the scientists shine a light at a given piece of paper from behind and photograph it from the front, using an off-the-shelf digital camera and concentrating on a marked rectangle of roughly four square inches. The image is sent to a computer or smartphone, which uses software to translate data on the paper's texture into a QR code. That code is encrypted with a digital signature that assures its authenticity; otherwise, a malefactor might create a seemingly legitimate code matching the texture of a forged document.

The process takes just 1.3 seconds, and it has worked flawlessly in laboratory experiments, the scientists say, accurately identifying real and fake documents. Authentication was even largely impervious to scribbling on the page, soaking it or heating it, although crumpling the page hurt the technique's accuracy.

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What might such a system look like in the real world? The scientists suggest imagining that every large bank note came with a digital "fingerprint" based on its unique beneath-the-surface pattern. A supermarket cashier receiving a $100 bill with this QR code printed on its face could run the bill through a low-cost reader that focuses on a marked area to ensure that the hidden texture there matched the one reported by the code—and that the data was encrypted with the correct secret digital key. The scientists note that this approach is cheap and fast and would enable documents to be authenticated anywhere the necessary device was on hand.

A second approach using the same technology could use the internet to refer to a central database of paper codes. Imagine an immigration officer encountering a traveler who presents a passport. The traveler's fingerprint could be taken to make sure the person matches the passport—even as the passport's paper texture was read and compared with the texture recorded in a government repository. In this case, no QR code would be needed.

As for producing a counterfeit—a second piece of paper with precisely the same pattern as another—the scientists say forget about it. The inner pattern of paper is hugely complex; the researchers note that their technique yields a digital fingerprint more detailed than those commonly used in iris-based recognition, a well-established means of identifying people. Said Feng Hao, one of the three scientists who worked on the project: "What we have shown is that every piece of paper contains unique intrinsic features, just as every person has unique intrinsic biometric features."

“Texture to the Rescue: Practical Paper Fingerprinting Based on Texture Patterns,” Ehsan Toreini, Siamak F. Shahandashti and Feng Hao, ACM Transactions on Privacy and Security (forthcoming).