

Towards copy-evident JPEG images

Andrew B. Lewis, Markus G. Kuhn

Some security documents are printed with a carefully adjusted “copy evident” background pattern that looks uniform to the unaided eye, but will show a clearly visible large-letter warning, like “COPY” or “VOID”, after having been photocopied. In general, these security-printing techniques cause nearly invisible high-frequency differences in the image signal to turn into clearly visible low-frequency components.

Are similar techniques possible with digital formats? Can we add some suitably crafted security patterns to digital images, videos, or audio recordings that remain imperceptible in the original output of the marking process, but may become visible (or audible) when standard lossy processing techniques are applied, such as resampling or requantization?

In this paper, we present our initial exploration of this area, demonstrating a technique for adding to JPEG images a high-frequency pattern that is imperceptible to the unaided eye, but turns into a clearly readable large-letter warning if the image is recompressed with some different quality factor. We exploit non-linearities in the JPEG process, in particular the clipping of the result of the inverse discrete cosine transform.

We embed a single pixel of the marking message in each 8×8 luma transform block. We replace each such block with an equivalent looking block that contains an added high-frequency checkerboard dither pattern. We choose the amplitude of that dither pattern such that half its pixel values end up close to the clipping limit (0 or 255). The exact amplitude chosen differs depending on whether the block represents a foreground or background pixel of the marking message. We choose this pair of amplitudes such that their values are (a) as close together as possible, (b) rounded in opposite directions after requantization, and (c) such that half of the pixels in a requantized foreground block will *exceed* the clipping limit after the inverse DCT in the decoder. As a result, the clipping operation in the decoder will affect the average pixel value in foreground blocks, but not in background blocks, leading to a visible difference.

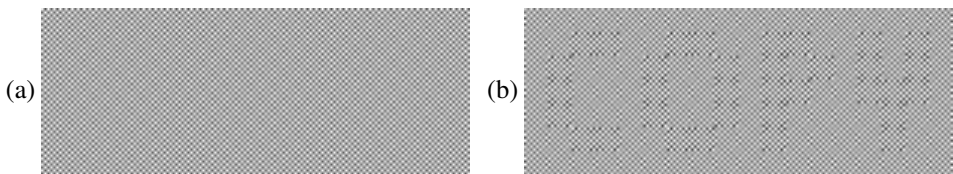


Figure 1: A bi-level image is embedded invisibly in a solid greyscale pattern giving (a). When the image is JPEG recompressed with a lower quality factor the message becomes visible (b).