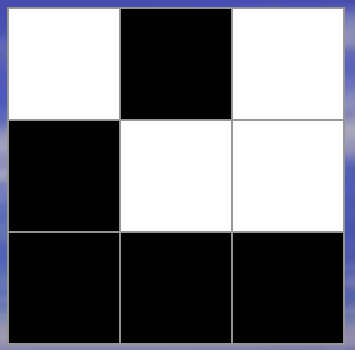
Crop-Resistant Watermarking with Binary Images

NSF REU Program

Watermarking



- Watermarking is an important security tool.
- In a full color or grayscale image, pixels can be changed by an imperceptible amount.
- In a binary image, a pixel is either black or white, so there are no subtle changes.

What can we do?

- Divide the image up into *n* sections, where *n* is the number of bits you wish to encode.

Encode with Parity

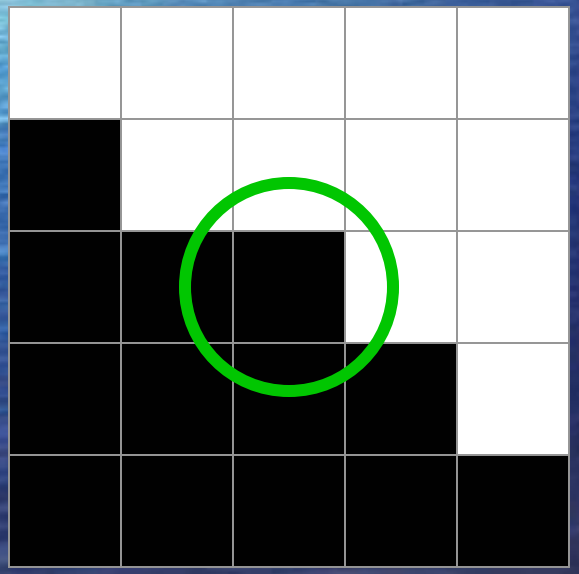
- Each section has either an even or odd number of black pixels in it. Change a pixel in each section to encode.

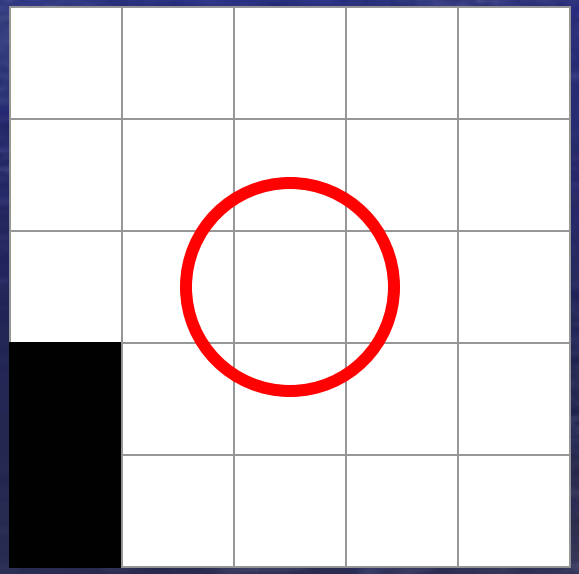
Problem!

- Some of the sections have no pixels that are easy to change.
- We “shuffle” the pixels.

Which pixels to change?

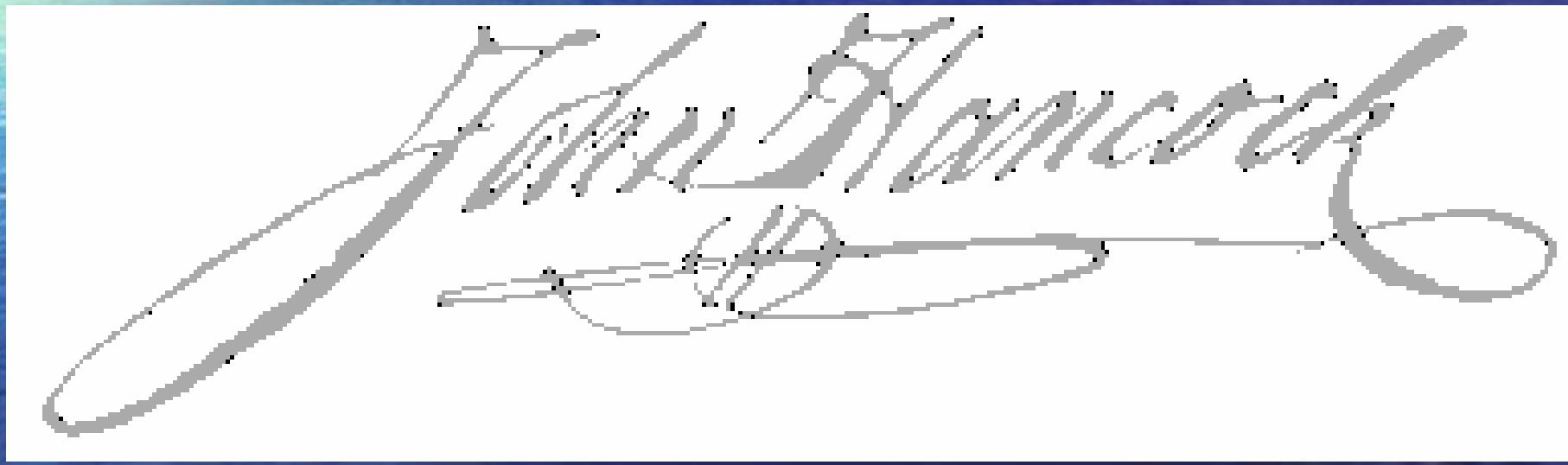
- Some pixels can be changed more easily than others.





Use a Rubric

- This image shows the pixels that one method finds very flippable.



Commence the Watermarking

Original Image

50 bits embedded – Almost the same

250 bits embedded – Visible Artifacts

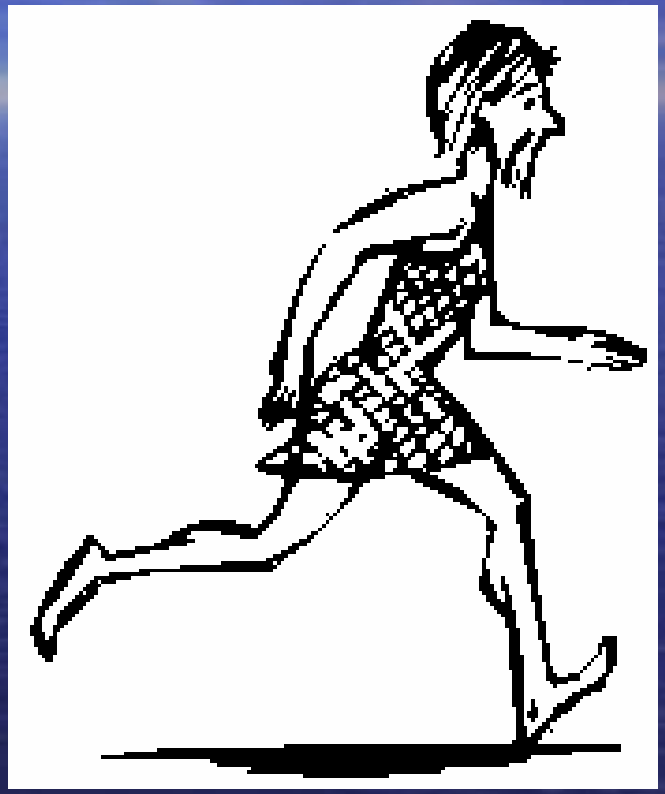
Other kinds of images

Lolcats are image macros combining photographs of a cat with a humorous and idiosy
rom lol and cat.[1][2] The phenomenon is also referred to as **Caturday** by users of 4ch
sharing imageboards and other internet forums.[4] Lolcats are similar to other anthropo
ut the cuteness of cats "enhances"[6] the appeal and increasing prominence[7][8][9] of

The term "lolcat" gained national attention in the United States when it was covered by
henomena of the sort are increasingly rare, stating that lolcats have "a distinctly old-s

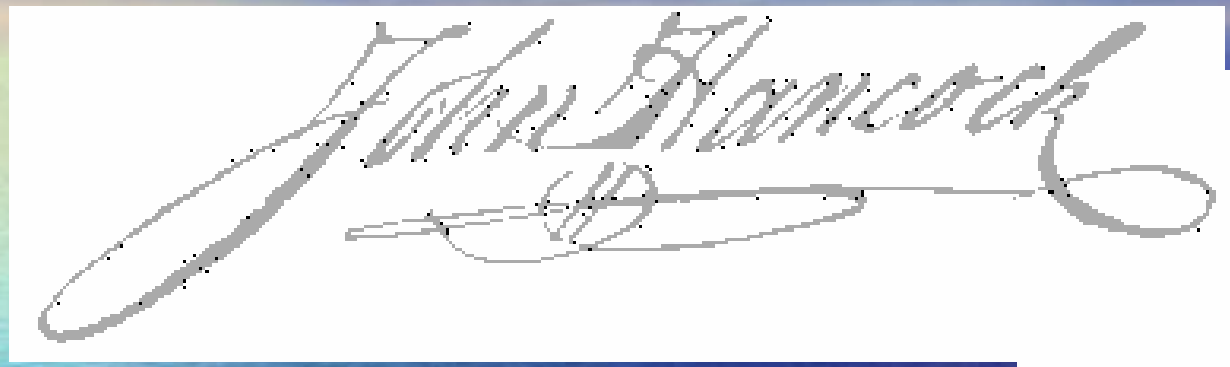
These images usually consist of a photo of a cat with a large caption characteristically
The image is, on occasion, digitally edited for effect. The caption generally acts as a s
description of the depicted scene. The caption is intentionally written with deviations fr
'strangely-conjugated verbs, but [a tendency] to converge to a new set of rules in spell
referred to as a type of pidgin[11] or baby talk.[13] The text parodies the grammar-poor
olcat captions take the form of snowclones in which nouns and verbs are replaced in a
seem to be specific to the lolcat form. Common themes include jokes of the form "Im i

30 bits are hidden –
some fonts are very regular,
Reducing the density of
Information that can be hidden.

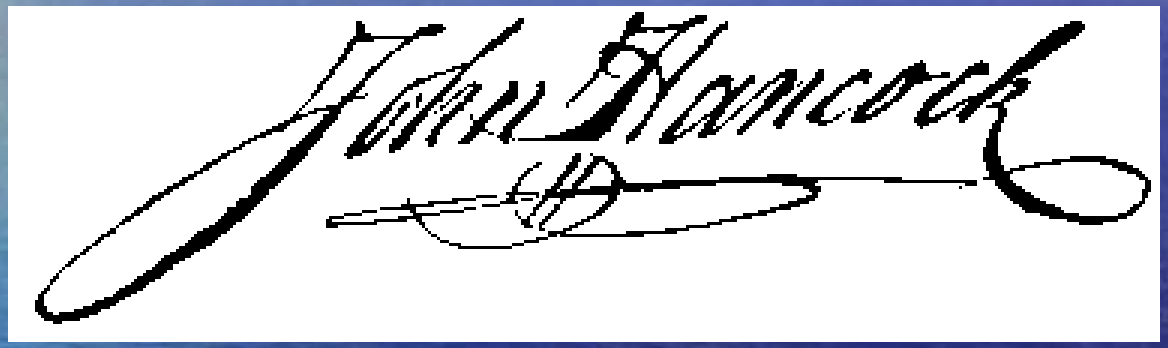


This drawing has lots of
Edges, so lots of data can
Be hidden invisibly

Hidden Information



Translation and/or Cropping!



Traps the Hidden Info

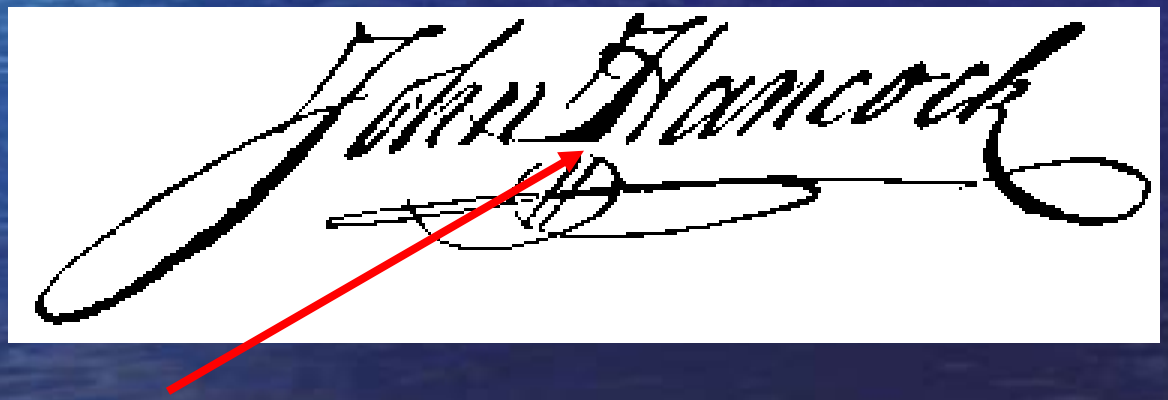
- In a translated image, nothing is in the right subsection any longer, so the decoding produces something unrelated to the message.
- In a cropped image, the deshuffling process breaks because the image isn't even the right size.

Can we fix it?

- Add a step to the encoding process.
- Will find ‘anchor points’ unlikely to be affected by watermarking or minor attacks.
- Keep track of shuffling map and anchor points in terms of a focus point selected for uncroppability, not a corner point.

Where's the Focus?

- The focus point is the point that we will use as 0,0.
- Slight benefits later if it's something that won't get cropped.



Anchor Picking

- Anchor points can be selected before or after watermarking. (After is slightly better.)

What to Retain?

- We need to retain three things about each anchor point: Its color, and its vertical and horizontal offsets from the focus point.
- We will use these to test potential focus points.

Anchor Picking

- When the image is translated, we can use the anchor points to relocate the focus point.
- Don’t need very many. More increases accuracy, but is actually slower.

Re-Centering the Image

- We have a set of anchor information. We will test each point in the cropped image to see if it is a good candidate focus point.
- Candidate focus points are ranked according to how many anchor points match. If no distortion occurred except for the cropping, they should all match.

Questions?