Correlation of intensities in a pixel neighbourhood

The problem to be presented will illustrate the fact that intensities in the neighbourhood of a given point are similar.

Problem Two friends, A and B, want to share photos but they want them to be unreadable by others. They invent the following "secrecy scheme". They take an image, and then permute its rows by a random but known permutation. They do the same with the columns. They are very satisfied with the result because the permuted image look nothing like the original.

Code

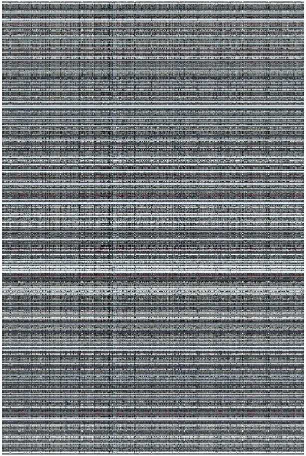
```
im = imread('photo1.jpg'); [M, N] = size(im);
row_permute = randperm(M); col_permute = randperm(N);
im_permuted = im(row_permute, col_permute);

% compute the inverse permutations for "decoding"
% the permuted image
aux = ones(1, M); aux(row_permute) = 1:M;
row_invpermute = aux;
aux = ones(1, N); aux(col_permute) = 1:N;
col_invpermute = aux;

% im_permuted(row_invpermute, col_invpermute)
% is the same as im.
```

Example

`im`

permute $\longrightarrow$

`im_permuted`



invpermute $\longleftarrow$

The mistake

A and B keep the permutations secret. But they make a big mistake because they publish the idea behind their secrecy scheme.

This gets them into trouble. Because it is known that pixels which are close in an image are likely to have similar intensities, their adversaries immediately try to construct an algorithm which will re-arrange the rows such that the overall distance between neighboring rows is minimised, meaning that

$$\sum_{i=1}^{M-1} \sum_{k=1}^{N} |J_{i,k} - J_{i+1,k}| \to \min \,, \tag{1}$$

where J is the image with re-arranged rows.
They also apply the same algorithm to the columns of the image.

The result

Greedy algorithm is used for re-arranging the rows and columns. It is not guaranteed to find the global minimum.

original

de-coded withouth knowledge of permutation vectors

Another example

original

de-coded withouth knowledge of permutation vectors