

Image Fraud Research: Block Artifact Grid Localization

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What is Block Artifact Grid Localization

- Block Artifact Grid localization uses the difference in the JPEG compression rates in image blocks to estimate the locations with a high amount of artifacts which are located in the specific blocks in point of forgery
- This method is based on the JPEG compression technique (see <https://en.wikipedia.org/wiki/JPEG>)

Steps 1

- divide the image into 8x8 blocks (as used in JPEG compression)
- take the DCT of the blocks (using an 8x8 DCT matrix and matrix multiply as done in JPEG compression)
$$im[i : endw, j : endh] < -round(T * im_{block} * t(T))t$$
 - * matrix multiply

Steps 2

- make a histogram of the (quantized between -257 to 257) DCT values for each of the 64 locations of 8×8 blocks (the number of blocks is equal to the number that can fit into the image (eg. $\text{round}(\text{nrow}/8) * \text{round}(\text{ncol}/8) / (8 \times 8)$) so the number of values in each histogram is equal to the number of blocks

$\text{hists}[i,j,] < -\text{histc}(\text{blockdct}[i,j,], -257 : 257)\text{cnt}$

Steps 2

If the histogram of DCT coefficients contains periodic patterns, then the coefficients are likely to have been quantized with a step of this periodic:

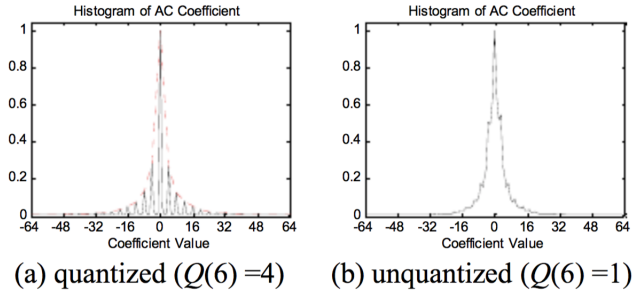


Fig. 1: Histogram of DCT coefficients

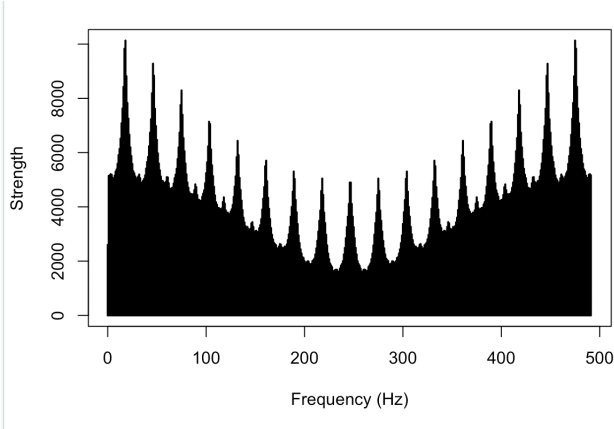
Steps 3

- take the FFT of the histogram of each of the 64 frequencies to get the periodicity and then power spectrum (absolute value) to get peaks (total size)

```
onehist <- array(hists[row, col, ], c(1, dim(hists)[3]))  
ffthists <- -abs(fft(onehist))
```

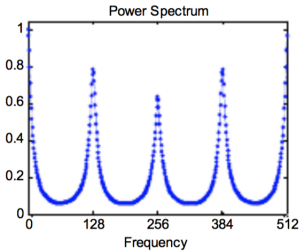
Steps 3

Row 1 column 4 of Q table estimation:

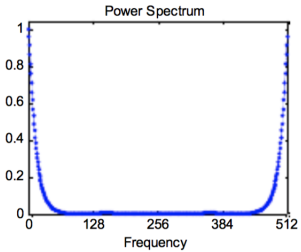


Steps 3

The power spectrum contains strong peaks (unlike the power spectrum of uncompressed image)

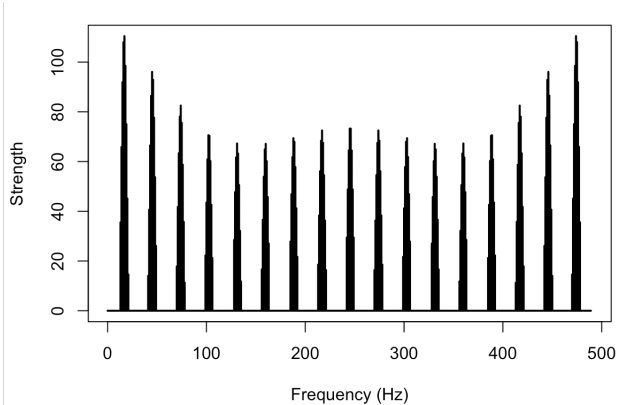


(a) power spectrum ($q=4$)



(b) power spectrum ($q= 1$)

Steps 4

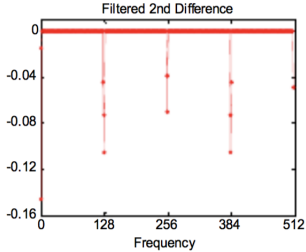
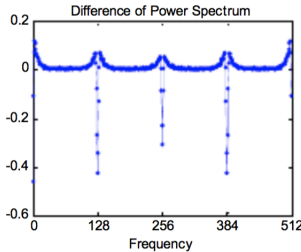


Steps 4

- calculate the number of local minimums of the filtered second derivative $secondDiff < -diff(diff(ffthists))$
- As shown (on the next slide) the local minimum number of peaks plus one is the estimated Q

Steps 4

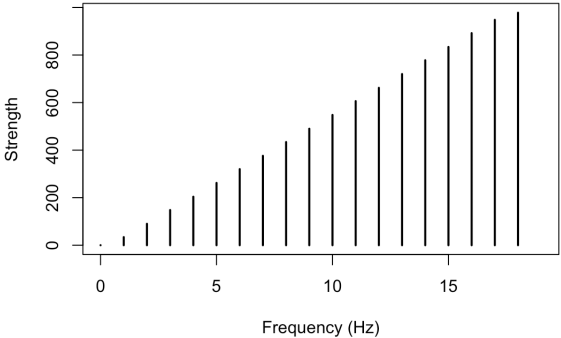
The low pass filtered 2nd order derivative (with positive values eliminated) in power spectrum provides a clear view of the peaks:



(c) 2nd order difference of (a) (d) filtered difference of (c)

Steps 4

This is a plot of the extreme values for another image (row 1 col 4)



Steps 5

- Once we get a Q estimate for at least 32 Q values in the matrix, we use the estimated Q to calculate the block artifact for each image block:

$$imblocks < -abs(blockdct - (Q2 * round(blockdct/Q2)))$$

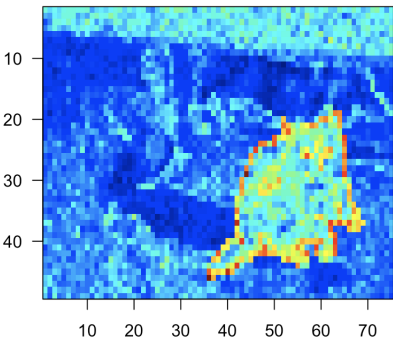
Steps 5

Here is an image where we can see the cat was forged:



Steps 5

Here is the output showing the heat map over the image. Blocks with a high artifact value from the equation above are bright yellow or red:



Steps 5

Here is another image where we can see the cat was forged:



Steps 5

Here is another example output:

