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EECE 566
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Project 1 Data and Analysis

Correct detections out of 1000 for various attacks of "lena256.bmp"

| Attack | JPG 90 | JPG 60 | JPG 5 | Hist. eq. | γ = 0.1 | γ = 5 | Wiener | Median | Resample to ½ size |
|---|---|---|---|---|---|---|---|---|---|
| σ = 1 | 1000 | 1000 | 759 | 1000 | 1000 | 1000 | 1000 | 998 | 1000 |
| σ = 2 | 1000 | 1000 | 943 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| σ = 5 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| σ = 10 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |

Correct detections out of 1000 for various attacks of "lena512.jpg"

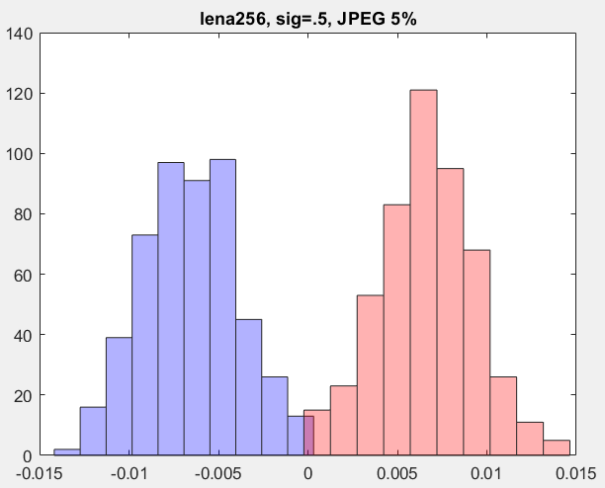
| Attack | JPG 90 | JPG 60 | JPG 5 | Hist. eq. | γ = 0.1 | γ = 5 | Wiener | Median | Resample to ½ size |
|---|---|---|---|---|---|---|---|---|---|
| σ = 1 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| σ = 2 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| σ = 5 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| σ = 10 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |

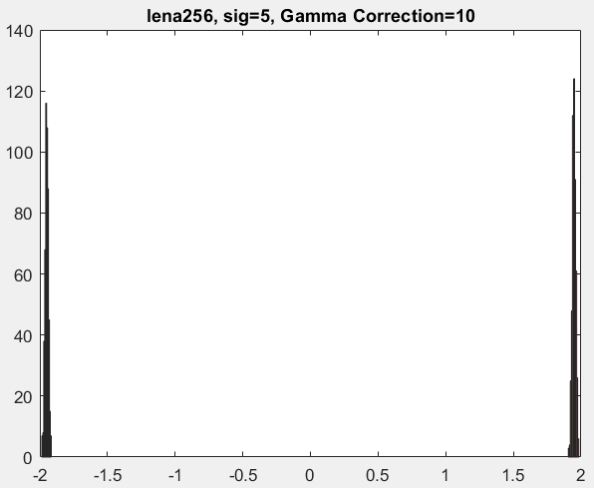
Error Probability Calculations

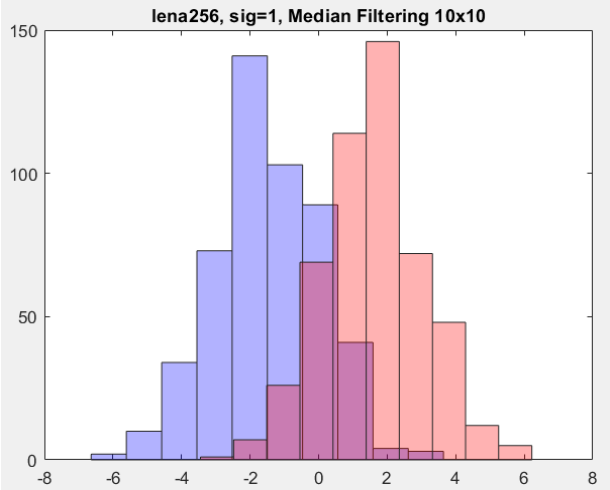
*The Pr(Error) shows as "0" for certain variance and attacks. This value is approximated by using:

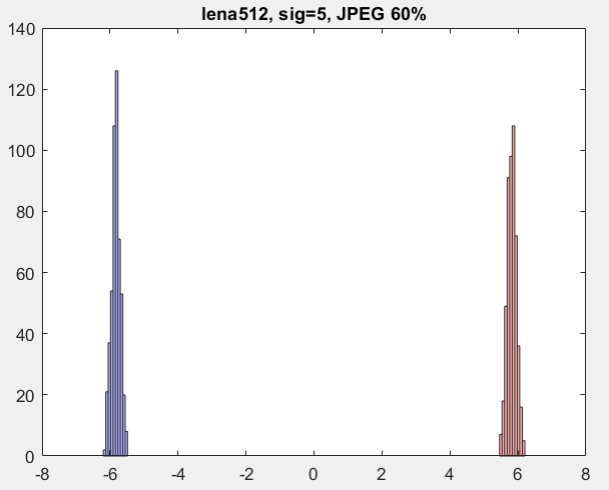
$$Pr(Error) = \frac{Q(\hat{p}0/\sigma 0)+Q(\hat{p}1/\sigma 1)}{2}$$ with the approximation of $Q(x) \approx \frac{e^{-x/2}}{\sqrt{2\pi x}}$ for large values of x.

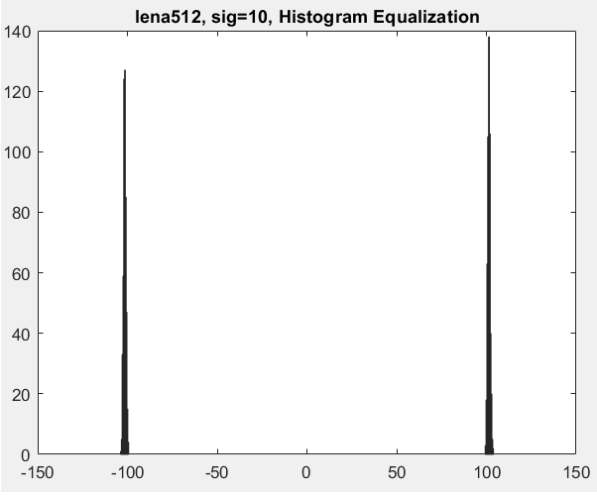
| Cases | $\hat{\rho}_0$ | $\hat{\rho}_1$ | $\sigma_0$ | $\sigma_1$ | Pr(Error) |
|---|---|---|---|---|---|
| lena256, σ = .5<br>5% quality JPEG | -0.0065 | 0.0067 | 0.0027 | 0.0027 | 0.0068 |
| lena256, σ = 5<br>γ correction = 10 | -1.9492 | 1.9482 | 0.0120 | 0.0125 | Approx:<br>$1.90*10^{-37}$ |
| lena256, σ = 1<br>Median Filtering (10x10) | -0.0015 | 0.0016 | 0.0015 | 0.0015 | 0.1539 |
| lena512, σ = 5, 60%<br>Quality JPEG | -5.8271 | 5.8193 | 0.1289 | 0.1313 | Approx:<br>$1.74*10^{-12}$ |
| lena512, σ = 10,<br>Histogram Equalization | -101.4870 | 101.3942 | 0.6902 | 0.6993 | Approx:<br>$6.10*10^{-35}$ |




Images encoded with a bit of "0" are represented by blue
Images encoded with a bit of '1' are represented by red

It can be observed that an increase in the value of σ for a set of watermarked images will group the values of the correlation coefficients further from the mean (or 0). Also the more aggressive attacks (decreasing the JPEG quality to 5% and applying a median filtering around a 10x10 area) will lead to a wider range of values for each set compared to the range of values as a whole. For example, the first graph shows that both the red and blue sets span about half of the overall range of values. This leads to a higher probability for error in the bit extraction.