# Ranking of manipulated images in a large set using Error Level Analysis

Daan Wagenaar & Jeffrey Bosma

University of Amsterdam

In cooperation with the Netherlands Forensic Institute

# Agenda

- Image Manipulation
- Research Question
- Error Level Analysis
- Methodology
- Experiments
- Results
- Conclusion
- Further Research
- Questions

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# Image Manipulation

- Examples
  - Red Eye removal
  - Brightness enhancements
  - Sharpening
  - …
- Most interesting manipulations
  - Internal copy & move
  - External copy & move

# Object removal

Stalin with Yezhov
(original)

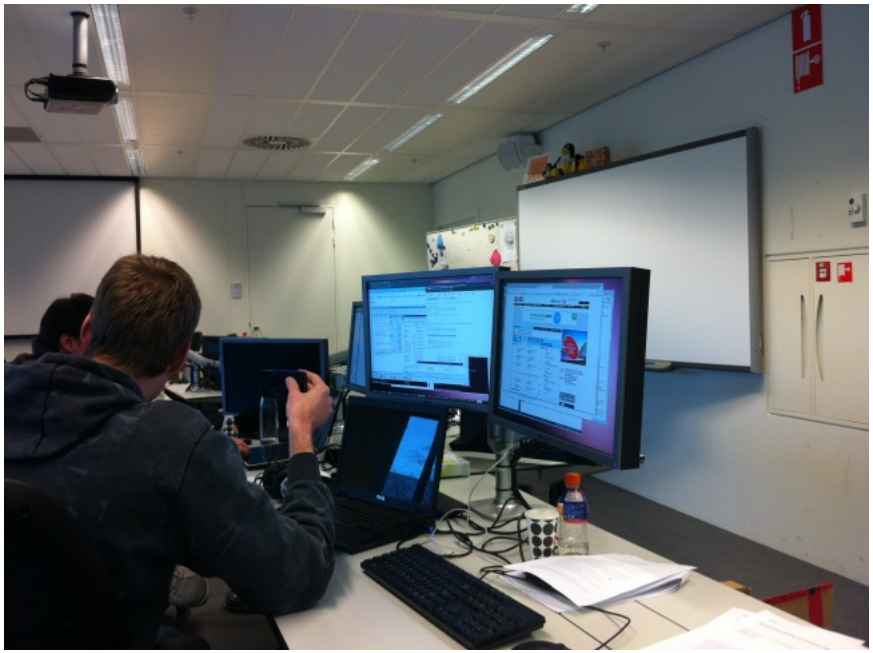
Stalin without Yezhov
(manipulated)

# Object appearance modification

Katie Couric
(original)

Slimmed Body
(manipulated)

# Object addition



Holding an iPhone
(original)

Holding a BlackBerry
(manipulated)

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# Research Question

- Problem:
  - A set of images as part of evidence
  - An expert manually inspects each image for manipulations
  - Time consuming process in a large set of images

- Can the Error Level Analysis technique be used to rank a set of images according to potentially present image manipulation?

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# Error Level Analysis (ELA)

- A technique for detecting image manipulations
- Uses properties of lossy image format
- Compares error caused by compression to a certain quality level
- An example:
  - Initial image at a quality level of 95%
  - ELA resaves this image at a certain quality level (e.g. 95%)
  - Compression introduces error
  - Compare error of initial and resaved image
  - Manipulated areas will have a different level of error
  - Differences are visibly expressed by brightness in a third image

Original image

ELA @75%

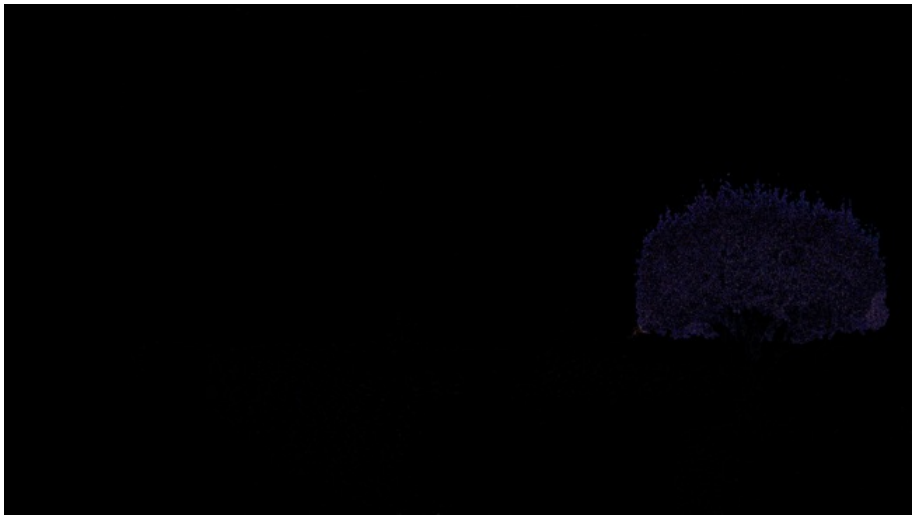
ELA @ 85%

ELA @ 95%

Manipulated image

ELA @75%

ELA @ 85%



ELA @ 95%

- Limitations
  - False positives can be caused by:
    - Sharp contrast, well-defined patterns
    - Recoloring, such as brightening, pallet skew, ...
  - False negatives can be caused by:
    - Low resolutions
    - Scaling
    - Low quality
    - Image scanning from other sources
    - Extremely skilled artists

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# Methodology

- Method 1: Average RGB values per block
- Method 2: Block to block comparison
- Method 3: Colored pixels ratio
- Method 4: Highest luminance value of the brightest pixel
- Method 5: Average luminance value of the 64 brightest pixels
- Method 6: Average luminance value of the brightest block

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# Experiments

- Goal
- Proof of concept
- Dataset of 300 images
  - 100 images with Canon PowerShot A630
  - 100 images with iPhone 4
  - 100 images with Samsung Digimax S500
- 30 manipulated images

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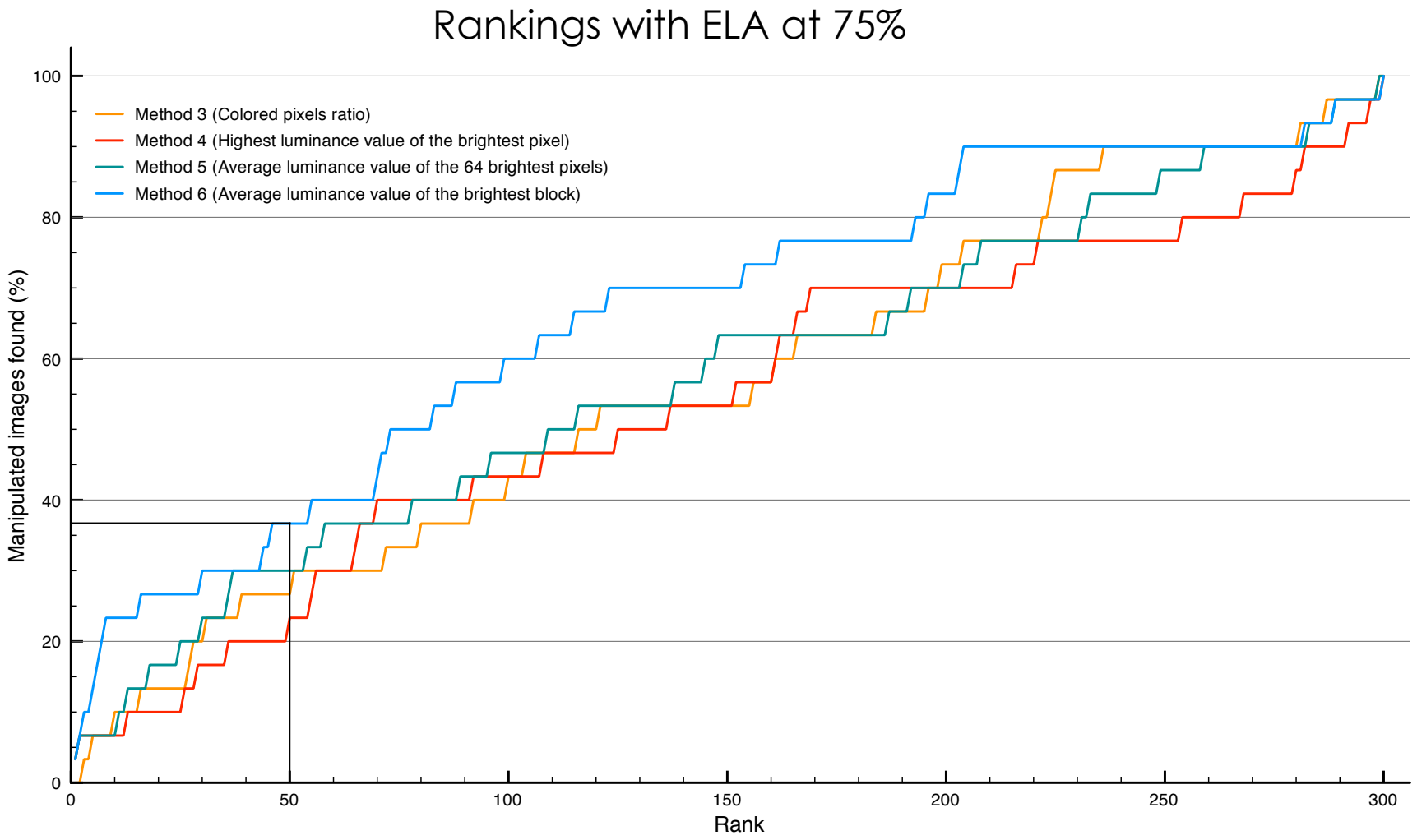
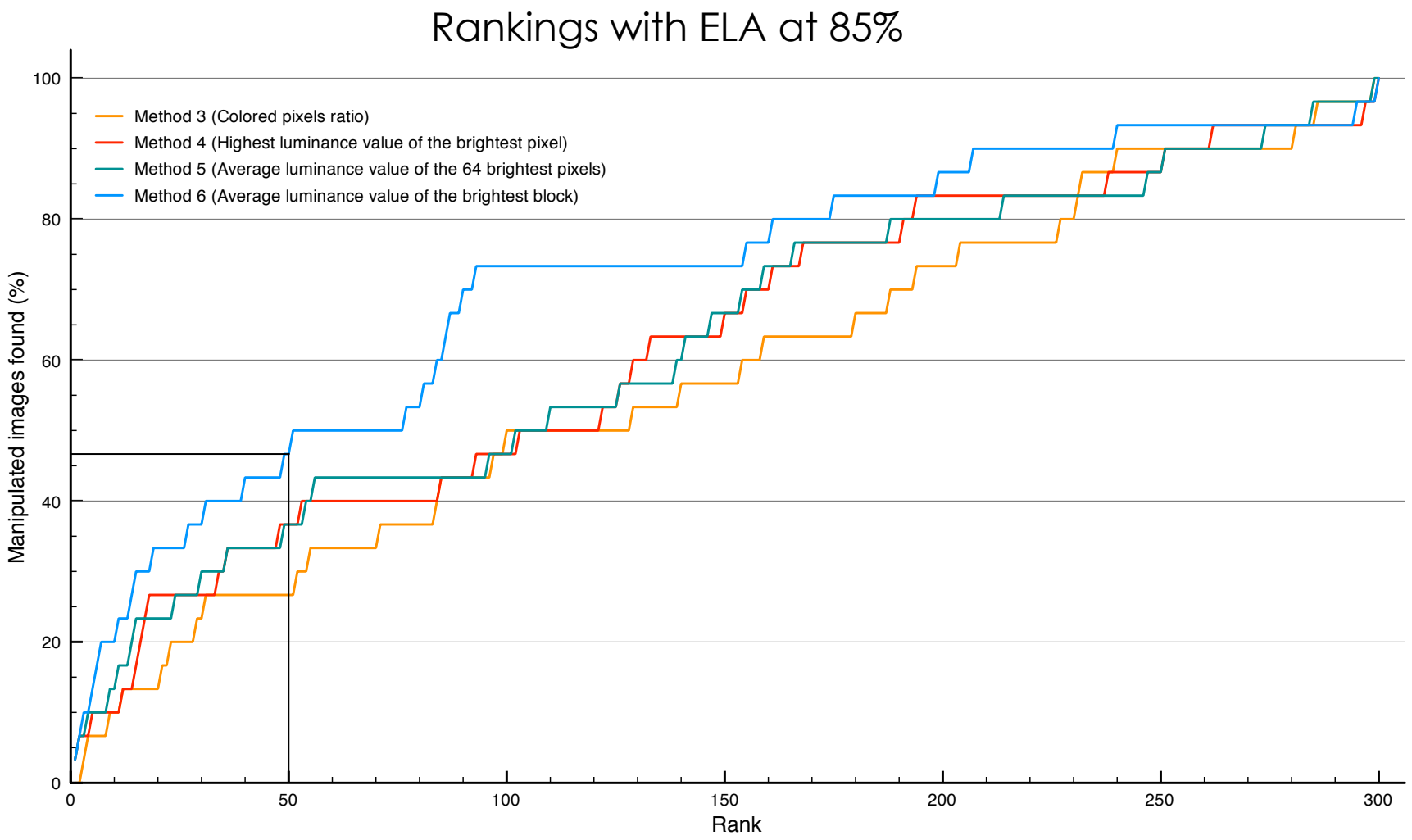
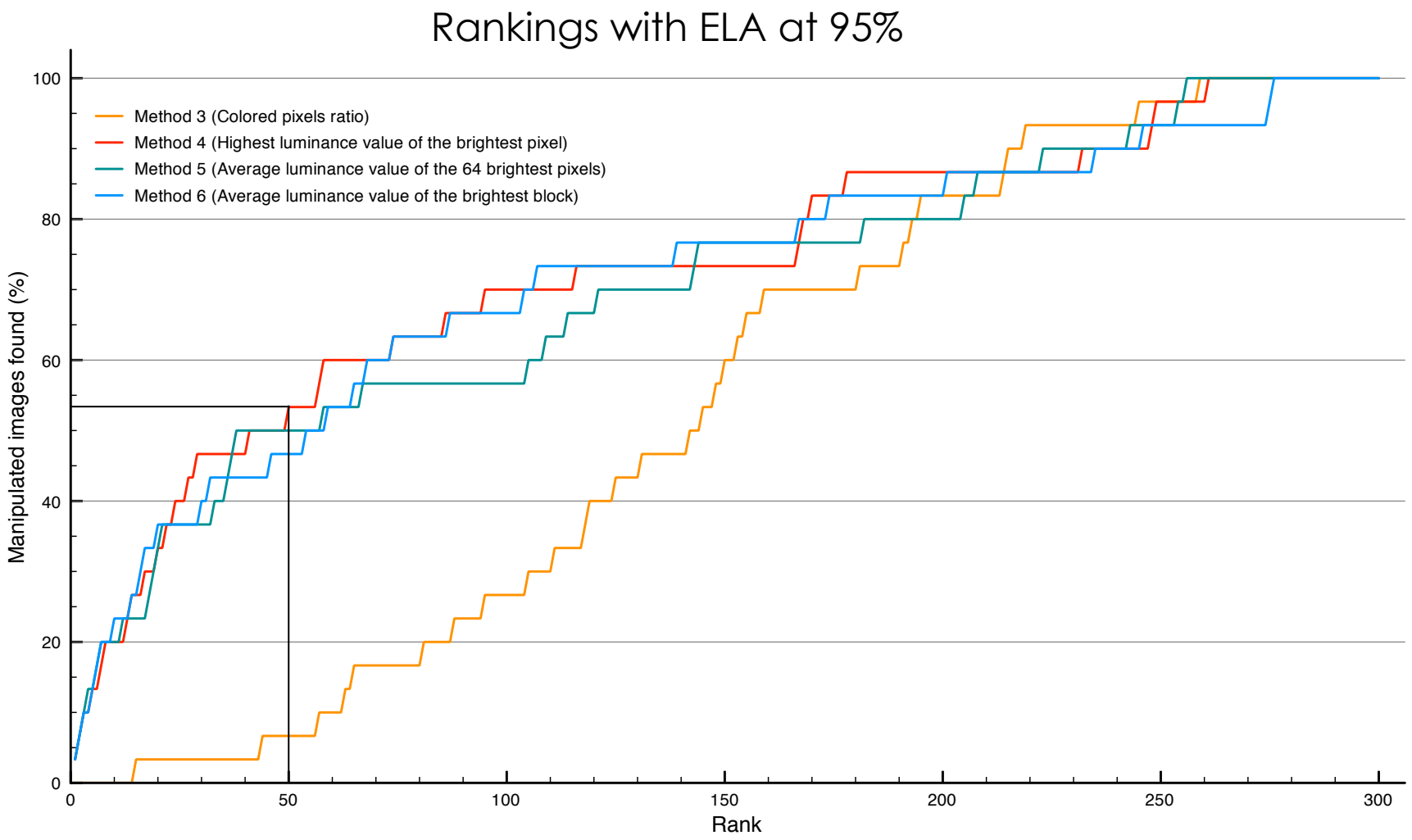
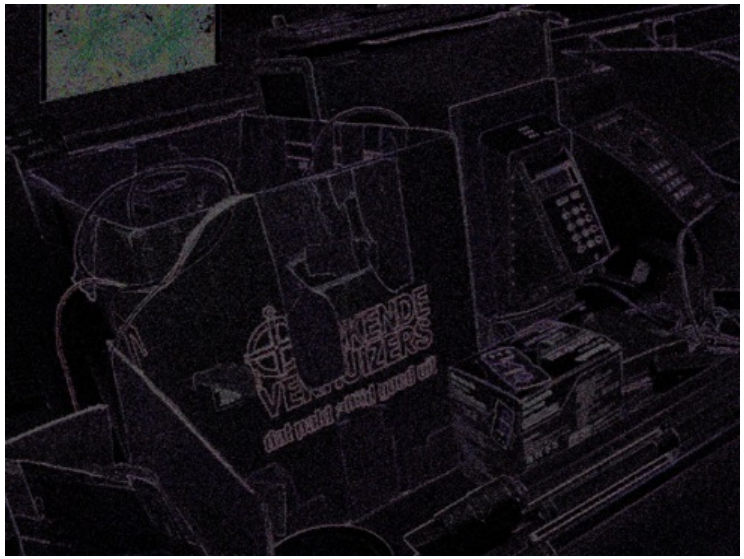
# Results


Rankings with ELA at 75%
Method 3 (Colored pixels ratio)
Method 4 (Highest luminance value of the brightest pixel)
Method 5 (Average luminance value of the 64 brightest pixels)
Method 6 (Average luminance value of the brightest block)
Manipulated images found (%)
Rank
0
20
40
60
80
100
0
50
100
150
200
250
300

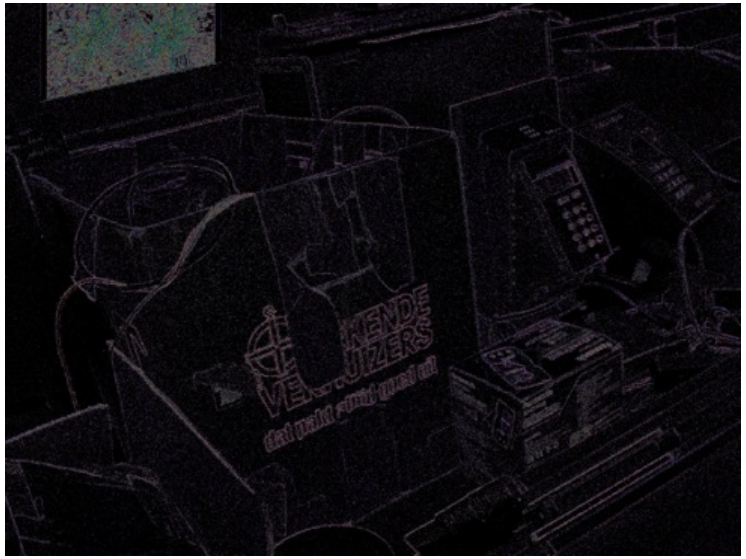

Rankings with ELA at 85%
Method 3 (Colored pixels ratio)
Method 4 (Highest luminance value of the brightest pixel)
Method 5 (Average luminance value of the 64 brightest pixels)
Method 6 (Average luminance value of the brightest block)
Manipulated images found (%)
Rank
0
20
40
60
80
100
0
50
100
150
200
250
300


Rankings with ELA at 95%
Method 3 (Colored pixels ratio)
Method 4 (Highest luminance value of the brightest pixel)
Method 5 (Average luminance value of the 64 brightest pixels)
Method 6 (Average luminance value of the brightest block)
Manipulated images found (%)
Rank
0
20
40
60
80
100
0
50
100
150
200
250
300

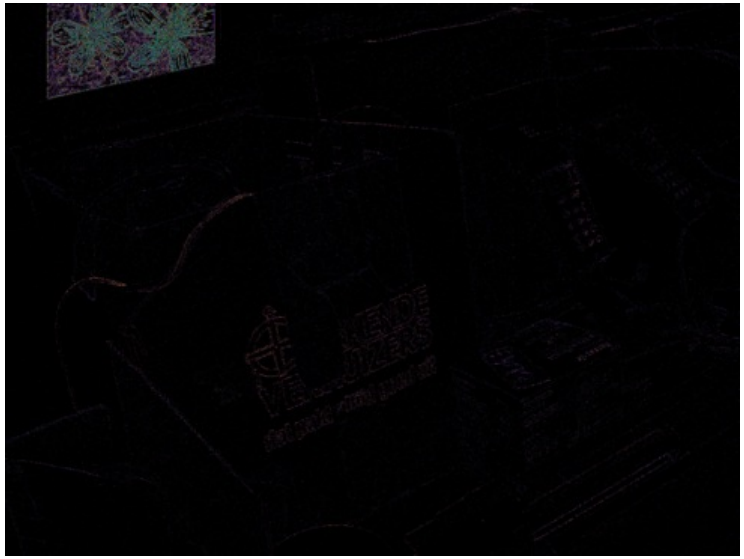

Manipulated image



ELA @75%



ELA @ 85%



ELA @ 95%

Manipulated image

ELA @75%

ELA @ 85%

ELA @ 95%

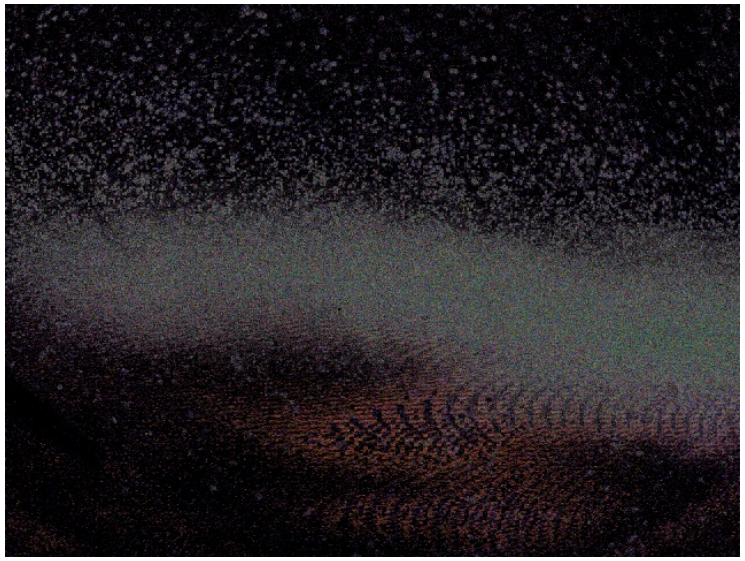

Manipulated image


ELA @75%

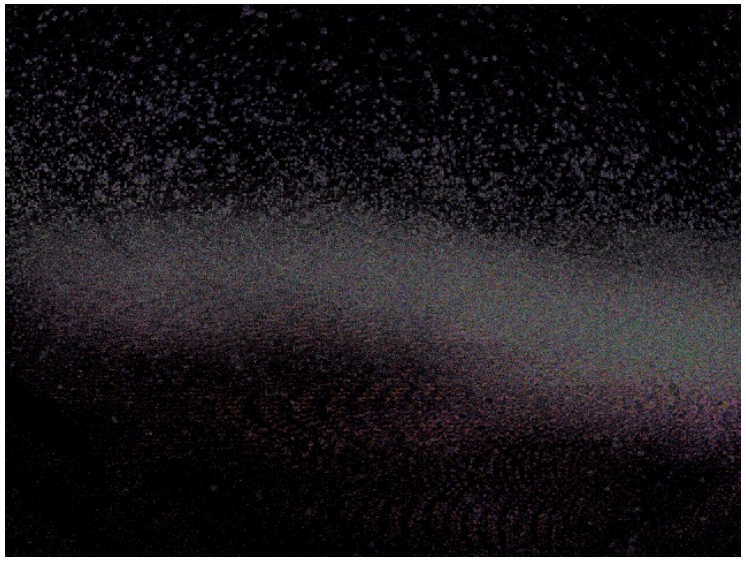

ELA @ 85%


ELA @ 95%

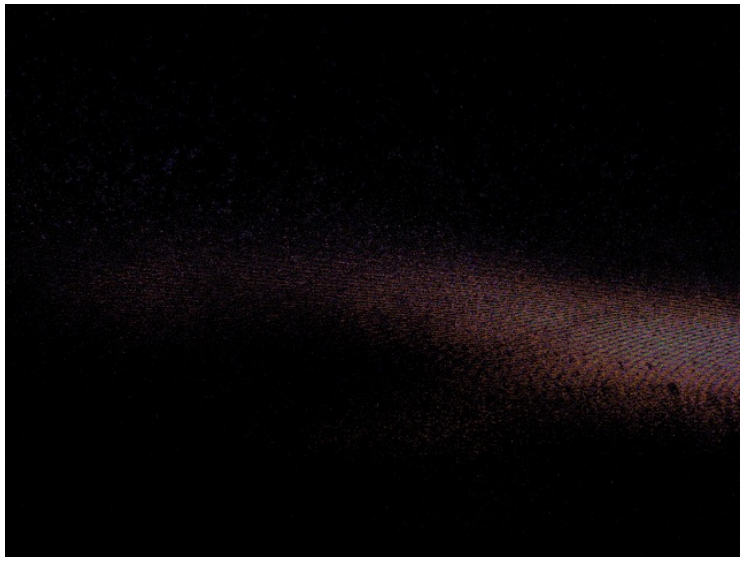
Original image



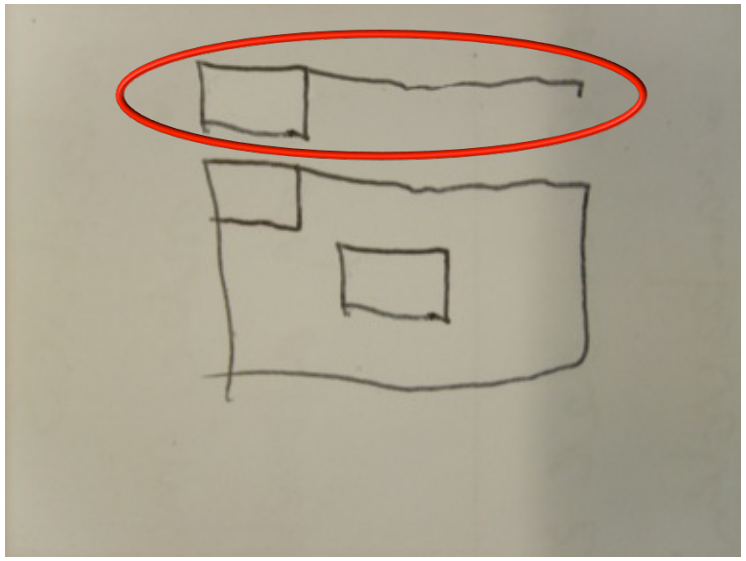
ELA @75%



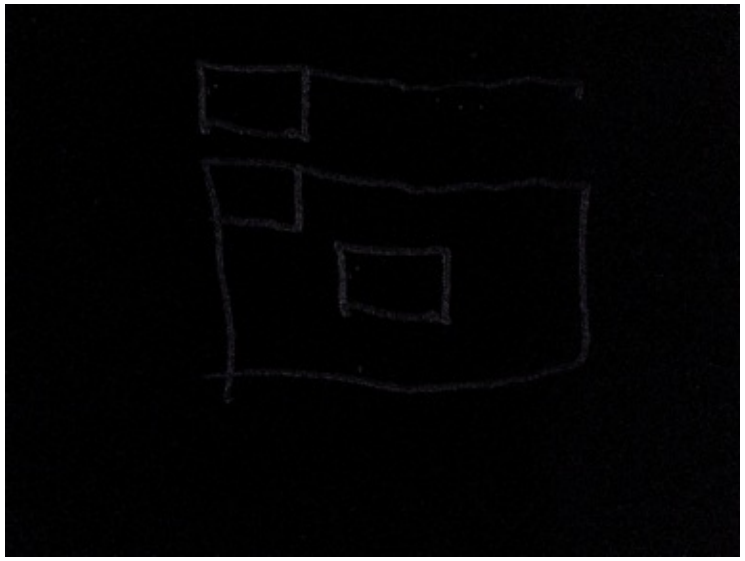
ELA @ 85%



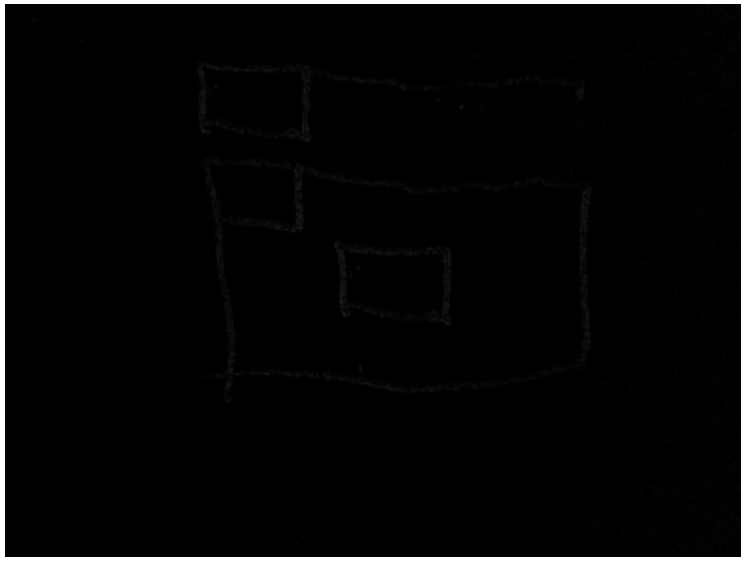
ELA @ 95%



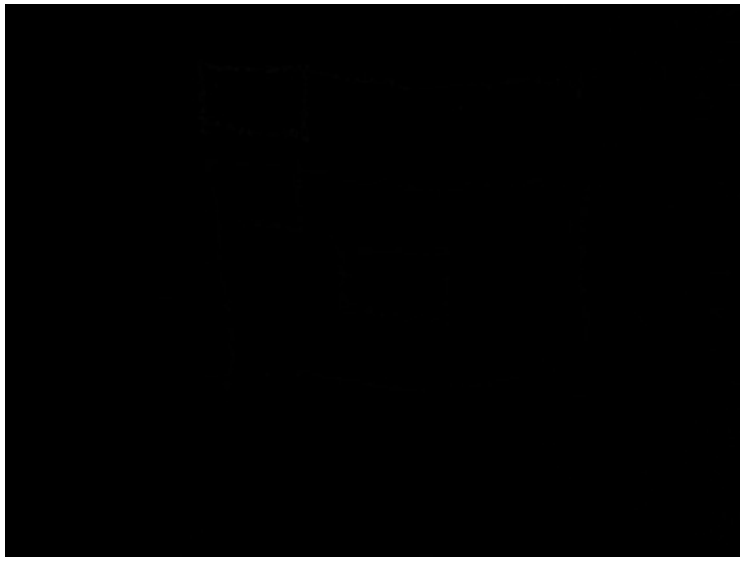
Manipulated image



ELA @75%



ELA @ 85%



ELA @ 95%

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# Conclusion

- Most effective method
- Limitations of ELA directly affect developed methods
- Detectable manipulation techniques

- Can the Error Level Analysis technique be used to rank a set of images according to potentially present image manipulation?
  - Yes, it is possible albeit not very reliable.

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# Further Research

- Alternative to ELA
- Combine different rankings
- Different methods

# Questions?