A Multiscale and Blind Forensic Technique for Median Detecting

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Outline

1. Motivation
2. Median Filtering Artifacts
3. Proposed Approach
4. Experiments
5. Conclusion
Median Filtering

✓ Replaces the central pixel by the median of values in a neighborhood defined by a sliding mask.

✓ Can be used to tamper images and hide traces of tampering [1].
Motivation

Figure 1: Median filtering used in image manipulation. Extracted from [2] and [3].
Figure 2: Anti-forensics technique by Kirchner and Bohme [1] to fool the resampling detection technique proposed by Popescu and Farid [4].
“Tools to detect this operation are paramount to help laws that regulate image manipulation in press, media and also in scientific publications”
A well known artifact of median filtering is the streaking artifacts [5].

- **Streaking**: redundant pixels in some image areas.

In median filtered images, the probability of 2 pixels in a given distance have the same value is high due to the nature of the median filtering.
Median Filtering Artifacts

Figure 3: (left) original image (right) streaking visible as similar pixels in some areas of the image after median filtering. Extracted from [5].
Proposed Approach

Hypothesis:

“Images never filtered have different behavior from already filtered images”
Proposed Approach

- Highlight the presence of median filtering by emphasizing streaking artifacts through multiple and multiscale perturbations gauged with IQMs.

- 8 IQMS are used in this work.

- Two class margin-based classifier (SVM) is used to discriminate between the pristine and median filtered images.
Proposed Approach

Figure 4: Proposed Approach.
1. Tuning of parameters:
   - 5x2 cross validation
   - Compressed images.
   - Just one blurring window (3x3)
2. Cross Dataset
   – 1 train with data of previous experiment.
   – 1 test with new data.
   – Compressed and never compressed images.
   – Four blurring windows in test dataset (3x3, 5x5, 7x7, 9x9).
   – Comparison with the state of the art.
Experiments

<table>
<thead>
<tr>
<th>#Perturbations</th>
<th>Window Size</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3x3</td>
<td>98.8% ± 0.22</td>
</tr>
<tr>
<td>4</td>
<td>All windows (multiscale)</td>
<td>98.7% ± 0.29</td>
</tr>
<tr>
<td>3</td>
<td>All windows (multiscale)</td>
<td>98.7% ± 0.28</td>
</tr>
</tbody>
</table>

Table 1: Results after 5x2 cross validation experiments.
Experiments

Figure 5: Tukey test pairwise comparison in factor perturbation.
Figure 6: Tukey test pairwise comparison in factor window.
## Experiments

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Accuracy</strong></td>
<td>82.1%</td>
<td>84.5%</td>
<td>70.1%</td>
<td>70.1%</td>
<td>65.1%</td>
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<tr>
<td><strong>Sensitivity</strong></td>
<td>92%</td>
<td>91%</td>
<td>98%</td>
<td>88%</td>
<td>99%</td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td>72%</td>
<td>77%</td>
<td>42%</td>
<td>52%</td>
<td>31%</td>
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<tr>
<td><strong>Precision</strong></td>
<td>76%</td>
<td>80%</td>
<td>62%</td>
<td>64%</td>
<td>59%</td>
</tr>
<tr>
<td><strong>Significant?</strong></td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
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|                |        |        |         |         |         |

Table 2: Compressed cross dataset experiments with two of the proposed methods (TPMW, FPMW) against the state of the art.
<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>82.2%</td>
<td>80.8%</td>
<td>77.9%</td>
<td>74.2%</td>
<td>79.9%</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>78.2%</td>
<td>74.4%</td>
<td>68.3%</td>
<td>76.9%</td>
<td>90.9%</td>
</tr>
<tr>
<td>Specificity</td>
<td>90.2%</td>
<td>91.5%</td>
<td>90.6%</td>
<td>78.6%</td>
<td>76.8%</td>
</tr>
<tr>
<td>Precision</td>
<td>88.9%</td>
<td>89.8%</td>
<td>87.9%</td>
<td>78.3%</td>
<td>79.7%</td>
</tr>
<tr>
<td>Significant?</td>
<td>✔</td>
<td>-</td>
<td>✔</td>
<td>✔</td>
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</tr>
</tbody>
</table>

Table 3: Compressed and Uncompressed cross dataset experiments with two of the proposed methods (TPMW, FPMW) against the state of the art.
We propose a novel way to detect median filtering in digital images.

Novelty:

“highlight the median filtering by emphasize it with multiple and multiscale filterings and measuring it with IQMs”
✓ Future work:
  – More image quality metrics in the analysis
  – Different image compression settings in dataset
  – Fusion of classifiers.
  – Study the proposed technique under anti-Forensic Approaches [7].
References


Questions?

The source code can be found in:

http://www.ic.unicamp.br/~anselmoferreira/projects/mfd

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