Median Filtering Forensics Based on Discriminative Multi-Scale Sparse Coding

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Background: Median Filtering Forensics

Non-median Filtered

Median Filtered
Background: Median Filtering Forensics

Non-median Filtered

Median Filtered
Median filtering tampering/forgery:
Use median filter to **smooth** the splicing boundaries

**Cover** tampering traces in many other image forgeries
Background: Median Filtering Forensics

Non-median Filtered

Median Filtered

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- Median filtering smoothes out the image and reduces noise compared to non-median filtering.
Background: Median Filtering Forensics

Non-median Filtered

Median Filtered

Streak Artifact
The Proposed Method: DSC

- Transform the image into different overlapping patches
- Train different discriminative dictionaries for different patches
- Max-pooling to reduce the feature dimension

The Flowchart of DSC method:
model image local texture at different level
Feature Extraction

Multi-scale Patch Domain Modeling
Feature Extraction

- Characterizing image patches with sparse codes

\[ w = \arg \min_{c \in \mathbb{R}^d} ||p - Dc||_2 \text{ s.t. } ||c||_0 \leq T \]

- Discriminative dictionary learning

\[ D_{opt} = \arg \min_D ||P - DW||_2^2 + \alpha ||L - AW||_2^2 \]
\[ + \beta ||S - BW||_2^2 \text{ s.t. } \forall i, ||w_i||_0 \leq T \]

- Feature Generation by Max-pooling

\[ f_{b \times b}(j) = \begin{cases} 
(w_1,j, \ldots, w_N,j)_{\text{max}}, & 1 \leq j \leq d \\
(-w_1,(j-d), \ldots, -w_N,(j-d))_{\text{max}}, & d \leq j \leq 2d 
\end{cases} \]
Feature Extraction

Final Feature:

\[ F = \{f_{3 \times 3}, f_{5 \times 5}, \ldots\} \]
**Experimental Setup**

- **Database:** UCID image database
  - Train set : Test set = 3:1
- **Classifier:** C-SVM with linear kernel
  - Five-fold cross-validation
- **Twenty times repeating experiments**

\[
\text{Accuracy} = \frac{\text{Correctly predicted samples}}{\text{Total testing samples}}
\]
The combination of patch 3*3 and 5*5 is a better choice.
The performance improvement is more apparent for images with smaller size and with stronger compression.
Blind Median Filtering Detection

MF35: 3*3 and 5*5 median filtered images
ALL : original, Gaussian filtering, average filtering and rescaled images

The proposed method is robust against various kinds of image manipulations
Conclusion

Three distinguishing characteristics of the proposed feature lie in:

i) The proposed sparse coding based feature is directly learned from the training samples;

ii) An overcomplete, discriminative dictionary is trained to represent various distinguishing patterns caused by median filtering;

iii) With the multi-scale patch analysis, the local image characteristics are analyzed with various resolutions, which makes the final feature more comprehensive.
THANK YOU!