Camera Model Identification Based Machine Learning Approach With High Order Statistics Features

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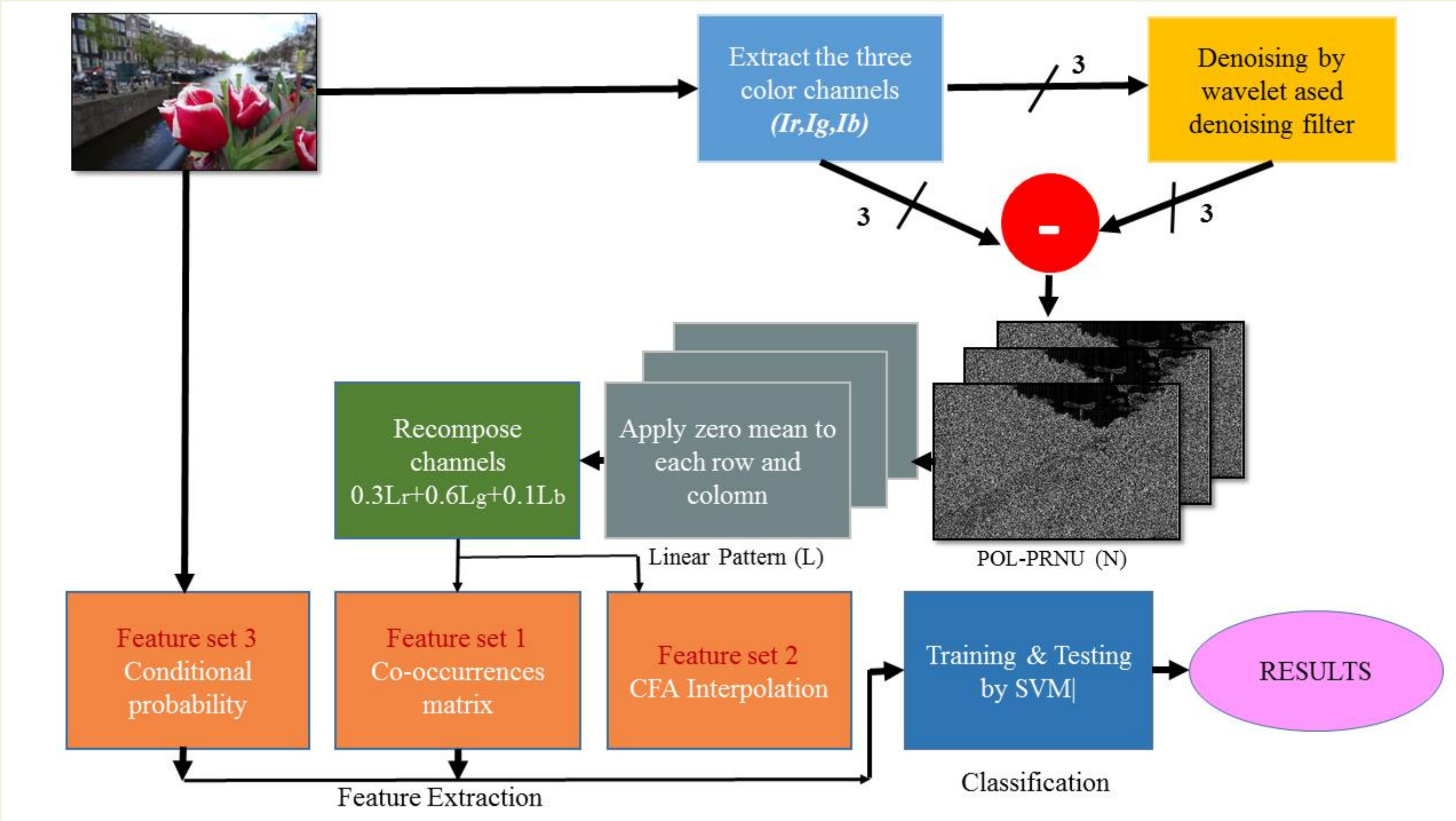
Proposed method

- Extract the noise residual: ***N=I-F(I)***.
- Normalize the noise residual and obtain L_r, L_g, L_b.
- Recompose channels: ***0.3Lr+0.6Lg+0.1Lb***.
- Extract two sets of features from the noise residual.
- Extract a set of feature from the original image.
- Classify with multi class SVM.



Feature set 1: Dim=10764

High order statistics from noise residual:

$$R \longrightarrow trunc_T\,(\mathrm{round}(L/q)),$$

where $trunc_T$ sets residual values in Tϵ{-T,…,T}, L is the POL-PRNU, and qϵ{1,1.5,2} The horizontal co-occurrences matrix C (resp. vertical):

$$C_d^h = \frac{1}{Z}\left|\{(i,j) \,|\, R_{i,j} = d1\,,\, R_{i,j+1} = d2\,,\, R_{i,j+2} = d3,\, R_{i,j+3} = d4\}\right|,$$

where Z is the normalization factor, $R_{i,j} \epsilon \mathbb{N}$, $d = (d1,...,d4) \in \{-T, \dots, T\}^4$ with $T=2$ [1].

Feature set 2: Dim=96

Traces of color dependencies in CFA interpolation:

Compute a set of the normalized cross correlation $\rho(C1,C2,\Delta)$ for $\Delta=\{\Delta 1\ \Delta 2\}$, $\Delta 1 \in \{0,\dots,3\}$, $\Delta 2 \in \{0,\dots,3\}$:

$$\rho(C1,C2,\Delta)=\frac{\sum_{i,j}(C1_{i,j}-\overline{C1})(C2_{i-\Delta 1,j-\Delta 2}-\overline{C2})}{\sqrt{\sum_{i,j}\,(C1_{i,j}-\overline{C1})^2\ \sum_{i,j}\,(C2_{i-\Delta 1,j-\Delta 2}-\overline{C2})^2}},$$

with $C1$,$C2$ two color channels of L and {C1,C2}∈{RR,GG,BB,RG,RB,GB} [2].

Feature set 3: Dim=72

Conditional Probability features for the 4 x 4 left upper sub-block of 8x8 DCT transform:

$$Prob\,(Y_j|X_i)=\frac{Prob(X_iY_j)}{Prob(Xi)}$$

X1 = {value at position r < value at position s},
X2 = {value at position r > value at position s},
X3 = {value at position r = value at position },
Y1 = {value at position t < value at position s};
Y2 = {value at position t > value at position s};
Y3 = {value at position t = value at position s};
where r, s, t are three relative positions in a DCT block such that {r, s, t} ϵ {1,…,4}x{1,…,4} [3].

Experiment Protocol and Results

- 14 camera models from Dresden database.
- (10764 + 96+72 = 10932) features trained by SVM classifier.
- 1400 images for training, 100 images for each camera model.
- 1400 images for testing, 100 images for each camera model.
- Implement the training procedure 10 times and average the results.

Camera Model (Dresden base)	Agfa DC733s	Agfa DC 830i	Agfa Sensor 530s	Canon Ixus55	Fujifilm FinepixJ50	Kodak M1063	Nikon D200	Olympus M1050SW	Panasonic DMC-FZ50	Praktica DCZ5.9	Samsung L74wide	Samsung NV15	Sony DSC-H50	Sony DSC-W170
Correlation m. (PRNU) 97.5% [4]	98	98	100	96	99	98	97	100	96	98	97	96	97	95
Proposed method 98.7%	99.3	98.6	100	99.9	98.7	99.9	98.1	98	99.6	98.2	99.4	98.9	97.7	96.2

Robustness test (Flickr base)

Camera Make/Model	No.Images	Iden. accuracy
Canon IXUS 55	97	99.1%
Fujifilm FinePix J50	74	98.7%

Conclusions

- A new method of camera model identification based machine learning approach.
- The results illustrate the efficiency of the proposed method since it provides 98.75% of accuracy compared to a correlation based method 97.5%.
- Future work: bigger database with more camera models, additional feature sets and a comparison with a CNN approach.

References

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[3] A.W. Abdul Wahab, A.T.S. Ho, and S. Li, “Intercamera model image source identification with conditional probability features,” in Proc. of the 3rd IIEEJ Image Electronics and Visual Computing Workshop, 2012.

[4] J. Lukas, J. Fridrich, and M. Goljan, “Digital Camera Identification from Sensor Pattern Noise”, IEEE Transactions on Information Forensics and Security, 2006.

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