The Effect of Centre-Symmetric Local Binary Pattern in Image Recapture Detection

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1. Introduction

The process of producing the real scene images and the corresponding recaptured images are shown in Figure 1 and Figure 2.

Figure 1: The process to produce a real image.

Figure 2: The process to produce a recaptured image.

Displaying or printing a scene on any type of physical media, lead to poor quality of recaptured image. It may be identified by some artefacts like texture pattern, colour fading etc. very easily as shown in Figure 3.

Figure 3: Comparison of a real image (a) and a recaptured image (b).

(a) (b)

2. Objectives

- To study the problem of distinguishing images of true natural scenes and recaptured images.
- To render unique properties for the image recapture recognition process.
- To evaluate the performance of the image recapture recognition method using the classification accuracy with additions of Centre-Symmetric Local Binary Pattern (CS-LBP) operator.

3. Dataset

- XintingGao et al., [1] presented smart phone recapture image database taken by smart phone cameras.
- The real-scene images are obtained by three popular brands of smart phones including Acer M900, Nokia N95 and HP iPAQ hw6960 which have back-facing camera.
- The recaptured images are obtained by using three types of DSLR cameras including Nikon D90, Canon EOS 450D and Olympus E-520.

3. Dataset …

Table 1 describes the total number of real images and Table 2 lists the total number of recaptured images that are used in this research.

Types	Images
Acer B	407
HP B	369
Nokia B	318
Total	**1094**

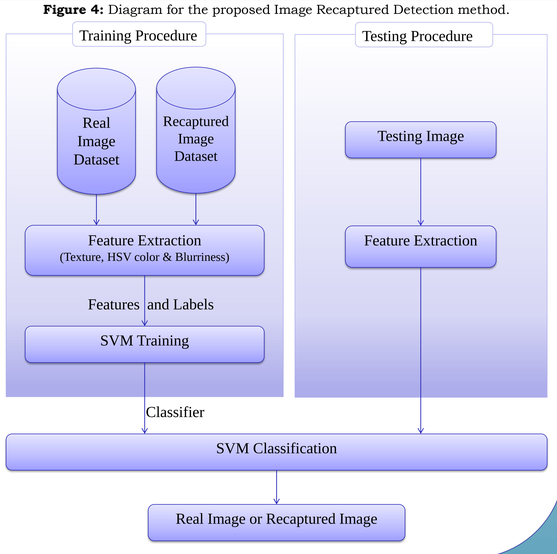
Table 1: The number of real images

Types of camera phones	Types	Images	Total
Acer B	LCD – NikonSLR	9	269
	PhotoGlossy – NikonSLR	20	
	PhotoGlossy - OlympusSLR	30	
	PhotoMatte - NikonSLR	30	
	PhotoMatte - OlympusSLR	37	
	PrintInk - OlympusSLR	50	
	PrintLaser - NikonSLR	93	
HP B	LCD – NikonSLR	06	398
	PhotoGlossy – CannonSLR	76	
	PhotoMatte - CannonSLR	73	
	PrintInk - CannonSLR	65	
	PrintLaser - CannonSLR	130	
	PrintLaser - NikonSLR	48	
Nokia B	PhotoGlossy – OlympusSLR	46	470
	PhotoMatte – OlympusSLR	80	
	PrintInk - OlympusSLR	169	
	PrintLaser - NikonSLR	35	
	PrintLaser - OlympusSLR	140	
Scenery in Total			1137

Table 2: The number of recaptured images

4. Methodology

Figure 4: Diagram for the proposed Image Recaptured Detection method.



4.1. Texture Feature

According to testing results in [2], in this experiment CS_ LBP is used as

$$cs\_LBP_{R,N,T(x,y)} = \sum_{i=0}^{\frac{N}{2}-1} s\left(n_i - n_{i+\left(\frac{N}{2}\right)}\right) * 2^i, s(x) = \begin{cases} 1 & if\ x>T \\ 0 & Otherwise \end{cases}$$

Where

(x,y) denotes the coordinates of a pixel,

n_i and $n_{i+(N/2)}$ corresponds to the gray level of the center-symmetric pairs of pixels of N equally spaced pixels on a circle of radius R.

4.2. HSV Color Feature

Figure 5: Comparison of the colour features introduced by the reproduction process.

(a) (b) (c)

- Moment 1 : Mean can be described as the average colour value in the image.

$$E_i = \sum_{j=1}^{N} \frac{1}{N} p_{ij}$$

- Moment 2 : Standard Deviation is the square root of the variance of the distribution.

$$\sigma_i = \sqrt{\frac{1}{N}\sum_{j=1}^{N}(p_{ij} - E_i)^2}$$

- Moment 3 : Skewness can be described as a measure of the degree of asymmetry in the distribution.

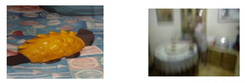
$$s_i = \sqrt[3]{\frac{1}{N}\sum_{j=1}^{N}(p_{ij} - E_i)^3}$$

Where

$P_{ij}-$ i^{th} color channel at the j^{th} image pixel.

$$\text{Color Feature} = \begin{pmatrix} E_{11} & E_{12} & E_{13} \\ \sigma_{11} & \sigma_{12} & \sigma_{13} \\ s_{11} & s_{12} & s_{13} \end{pmatrix}_{3X3}$$

4.3. Blurriness



$blur_F$ = 0.357930 $blur_F$ = 0.889063

Figure 6 shows the no-reference perceptual blur metric method Proposed by Crete et al.[3].

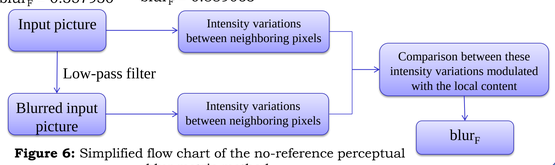


Figure 6: Simplified flow chart of the no-reference perceptual blur metric method.

5. Experimental Setup

Selection	Training set	Testing set
Selection I	70 %	30 %
Selection II	60 %	40 %
Selection III	50 %	50 %
Selection IV	30 %	70 %

Table 3: Training and testing image selection.

- Whole dataset is partitioned into training and testing images.
- Twenty six dimensional of physical features including Texture, HSV colour and Blurriness are extracted from the training images.
- Performance is measured using accuracy.

For a binary classifier,

$$Accuracy = \frac{(True\ positive + True\ Negative)}{Total}$$

6.1. Testing Result I

Selection	Accuracy
Selection I	86.67 %
Selection II	86.25 %
Selection III	84.50 %
Selection IV	78.21 %

Table 4: Recognition rate as accuracy with different image samples on Smart Phone Recapture Image Database [4].

Features	Dimensions	Accuracy
Physics [1]	166	91.3 %
Wavelet statistics [4]	216	80.67 %
Proposed method	26	86.67 %

Table 5: Comparison of feature dimension and performance achieved by different methods on smart phone recapture image database [4].

6.2. Testing Result II

Features	Dimensions	Accuracy			
		Section I	Section II	Section III	Section IV
Texture	16	90.00 %	85.00 %	82.00 %	74.29 %
HSV	9	56.67 %	62.50 %	62.00 %	54.29 %
Blurriness	1	63.33 %	55.00 %	49.00 %	50.00 %
Texture + HSV	25	80.00 %	75.00 %	72.00 %	70.00 %
Texture + Blurriness	17	90.00 %	85.00 %	82.00 %	74.29 %
HSV + Blurriness	10	70.00 %	60.00 %	58.00 %	58.57 %

Table 6: Dimensions and performance of the proposed method on the different combinations of image features.

6.3. Testing Result III

Brand	Accuracy			
	Section I	Section II	Section III	Section IV
Acer	81.67 %	81.25 %	74.00 %	72.14 %
HP	68.33 %	66.25 %	63.00 %	70.71 %
Nokia	76.67 %	72.50 %	76.00 %	72.14 %

Table 7: Performance of proposed method on the brands of smart phones.

Brand	Accuracy			
	Section I	Section II	Section III	Section IV
Acer	74.38 %	75.93 %	73.67 %	72.52 %
HP	76.52 %	77.52 %	75.98 %	69.27 %
Nokia	83.05 %	81.90 %	80.20 %	78.99 %

Table 8: Performance of CS-LBP operator on the brands of smart phones.

7. Conclusions

- This proposed method is efficient with good recognition rate of distinguishing real-scene images from the recaptured ones.
- The texture feature plays an excellent role in this method.
- The CS-LBP operator which is used to extract the texture feature is significant for the recognition problem.

8. References

[1] Y. Ke, Q. Shan, F. Qin & W. Min, (2013) "Image recapture detection using multiple features", *International Journal of Multimedia and Ubiquitous Engineering*, pp71-82.
[2] M. Heikkila & C. Schmid, (2009) "Description of interest regions with Local binary patterns", *Pattern Recognit.*, Vol. 42, No. 3, pp425-436.
[3] F. Crete, T. Dolmiere, P. Ladret & M. Nicolas, (2007) "The blur effect: perception and estimation with a new no-reference perceptual blur metric", SPIE *International Society for Optical Engineering*.
[4] X. Gao, B. Qiu, J. Shen, T.-T. Ng, &Y. Q. Shi (2011) "A smart phone image database for single image recapture detection", *Digital Watermarking 9th International Workshop, IWDW Revised Selected Papers*, pp90-104.