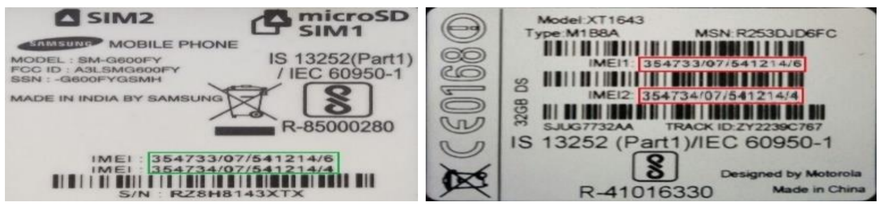
A New RGB based Fusion for Forged IMEI Number Detection in Mobile Image

[1]Palaiahnakote Shivakumara, [2]V. Basavaraja, [2]Harsha S. Gowda, [2]D. S. Guru, [3]Umapada Pal and [4]Tong Lu
[1]Faculty of Computer System and Information Technology, University of Malaya, Kuala Lumpur, Malaysia.
Email: shiva@um.edu.my
[2]Department of Studies in Computer Science, University of Mysore, Mysore, Karnataka, India.
Email: basavarajavyadav@gmail.com, harshasgmysore@gmail.com, dsguruji@yahoo.com
[3]Computer Vision and Pattern Recognition Unit, Indian Statistical Institute, Kolkata, India. Email: umapada@isical.ac.in
[4]National Key Lab for Novel Software Technology, Nanjing University, Nanjing, China. Email: lutong@nju.edu.cn

Motivation

- Creating Fake International Mobile Equipment Identity (IMEI) number for smart phone to smuggle the goods is a hot news for the researchers. Therefore, this work focusses on forged IMEI number detection.



(a) Mobile with original and forged IMEI numbers created by copy-paste operation are marked by green and red color, respectively.

(b) Segmented original and forged IMEI number from respective images shown in (a).

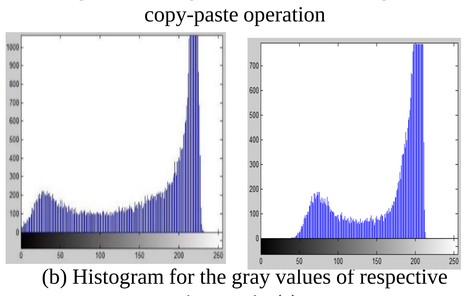
(c) Original and forged IMEI number created by insertion operation.

Illustration for creating forged IMEI numbers using original IMEI numbers printed on mobile phone images.

Proposed Method

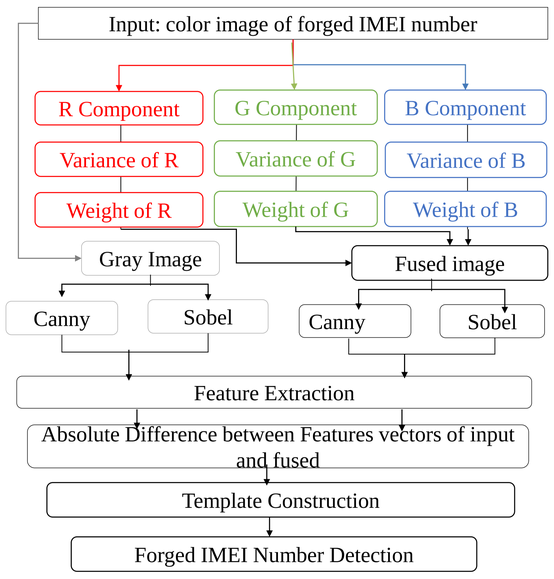
- We present here a new fusion based method using R, G and B color components for detecting forged IMEI number.
- The proposed method finds variances for each color components of the input image.
- The variances are used to derive weights for respective color components. The weights are convolved with the pixels of color components, which gives fused image.
- For the fused image, the proposed method extracts features based on sparsity, average intensity values and number of connected components.
- The absolute difference between feature vectors of fused and input image is considered for template creation and then forgery detection.

(a) Original and forged IMEI number images with copy-paste operation



(b) Histogram for the gray values of respective images in (a).

Distributions of gray pixel values for the original and forged IMEI number images shown in (a).



Block diagram of the proposed method.

Constructing Fused Image using Color Components

$$Var_K = \sqrt{(RF)^2 + (CF)^2} \qquad RF = \sqrt{\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=2}^{N}[F(i,j) - F(i,j-1)]^2}$$

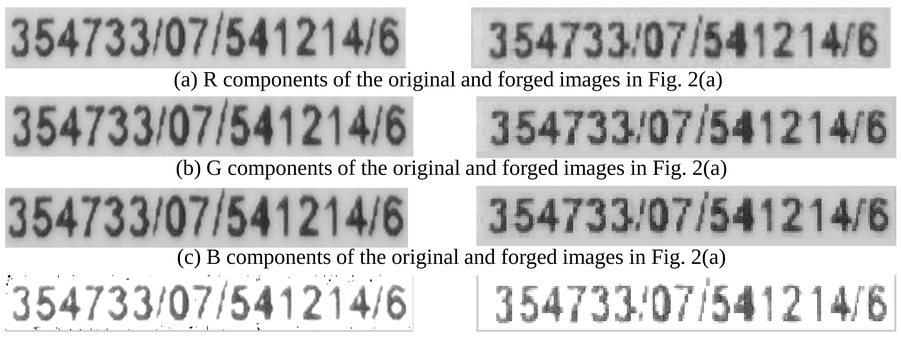
$$CF = \sqrt{\frac{1}{MN}\sum_{j=1}^{N}\sum_{i=2}^{M}[F(i,j) - F(i-1,j)]^2}$$

where k indicates, R, G, B, RF and CF denote variances computed in row and column wise, respectively. F denotes input image, M and N denote the number of row and columns respectively for the window of size 3×3.

$$W_K(x,y) = \frac{Var_K(x,y)}{Var_R(x,y) + Var_G(x,y) + Var_B(x,y)}$$

$$S(x,y) = f_R(x,y) * W_R(x,y) + f_G(x,y) * W_G(x,y) + f_B(x,y) * W_B(x,y)$$

Where W denotes weights of R, G, and B components, respectively, and S denotes Fusion of Weight(W_k) with corresponding color components(f_k).



(a) R components of the original and forged images in Fig. 2(a)

(b) G components of the original and forged images in Fig. 2(a)

(c) B components of the original and forged images in Fig. 2(a)

(d) Fused images for respective original and forged images

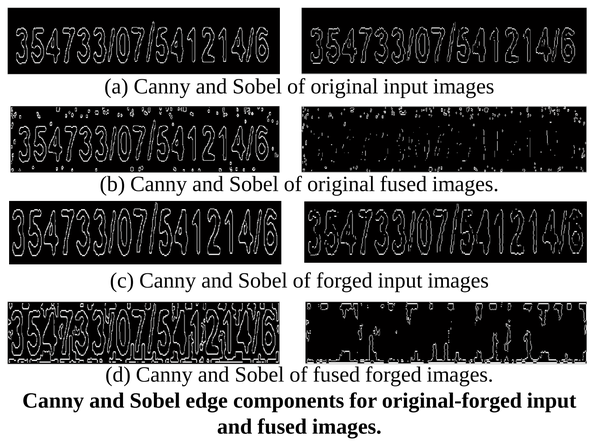
Generating of fused images using R, G and B components for the original and forged IMEI number images.

Feature Extraction for Forged IMEI Number Detection

- $SP = \begin{cases} S + 1 & if\ no\ white\ pixel\ in\ the\ path \\ 0 & otherwise \end{cases}$
- $CC = \begin{cases} C + 1 & if\ a\ edge\ componet\ is\ connected \\ 0 & otherwise \end{cases}$
- $AI = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N} f(i,j)$

Where *SP* denotes sparsity count, *CC* denotes connected component count, *AI* denotes average intensity, *M*, *N* denote the number of row and columns of the image and *f(i, j)* is image.

- $CD1 = |ISPc - FSPc|,\ CD2 = |ICCc - FCCc|$,
- $CD3 = |IAIc - FAIc|,\ SD1 = |ISPs - FSPs|,$
- $SD2 = |ICCs - FCCs|,\ \ SD3 = |IAIs - FAIs|$



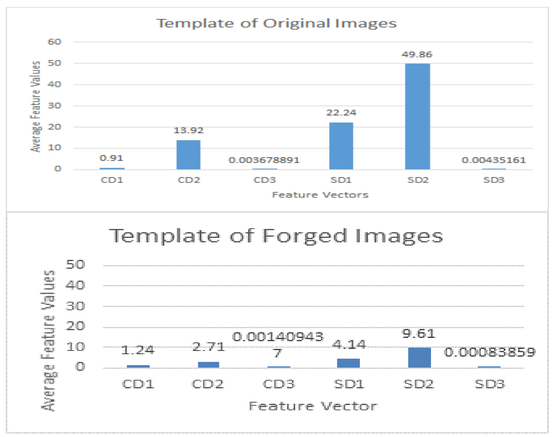
(a) Canny and Sobel of original input images

(b) Canny and Sobel of original fused images.

(c) Canny and Sobel of forged input images

(d) Canny and Sobel of fused forged images.

Canny and Sobel edge components for original-forged input and fused images.



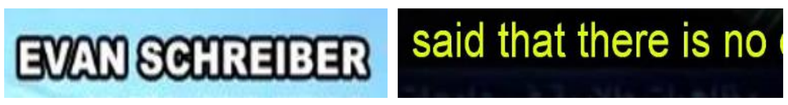
Templates construction for average feature vectors of original and forged images.

Experimental Results

- We use 100 forged and 100 original images for experimentation. In addition, 1300 scene images are from Roy et al and Bhardwaj et al datasets together.

(a) Original and forged samples images of our dataset with copy-paste operation

(b) Original (scene) and forged (caption) images of Roy et al. dataset.



(c) Forged images (caption text) of low and high resolution of Bharadwaj et al. dataset.

Sample successful results of the proposed method

Table I. Performance of the proposed and existing methods on our dataset and Roy et al. datasets

Methods	Original			Forged		
	R	P	F	R	P	F
Proposed	0.73	0.82	0.77	0.85	0.75	0.80
Roy et al	0.67	0.64	0.65	0.63	0.65	0.64
Bhardwaj	0.58	0.60	0.59	0.62	0.59	0.60
Kumar et al.	0.43	0.42	0.42	0.41	0.41	0.41

Methods	Original (scene)			Forged (caption)		
	R	P	F	R	P	F
Proposed	0.54	0.96	0.69	0.98	0.68	0.80
Roy et al.	0.75	0.71	0.73	0.63	0.68	0.65
Bhardwaj	0.56	0.46	0.51	0.40	0.51	0.45
Kumar et al.	0.55	0.44	0.48	0.39	0.50	0.44

Table II. Performance of the proposed and existing methods on Bharadwaj et al. dataset.

Methods	Set-1(Low resolution)			Set-2(High resolution)		
	R	P	F	R	P	F
Proposed	0.73	0.70	0.72	0.80	0.74	0.76
Roy et al.	0.62	0.58	0.60	0.66	0.63	0.64
Bhardwaj	0.64	0.62	0.63	0.68	0.65	0.67
Kumar et al.	0.41	0.37	0.39	0.45	0.40	0.43

Conclusion

- We have proposed a novel fusion method for detecting forged IMEI number in mobile images using R, G and B color components and statistical features.
- The variance for the each color component is estimated and then the same variance are used for deriving weights.
- The weight information is convolved with the input images to obtain fused image.
- The proposed method extracts features for the fused images with the help of Canny and Sobel edge images.
- Templates are constructed based on average of feature vectors for forgery detection.
- The same method can be extended to other forgery detection applications in future.