

# Identigram/Watermark Removal using Cross-channel Correlation

## **Problem Definition**

identigram/watermark - $\bigcirc$ Original contents

We assume original and identigram layers are

- Independent
- Additive

Which can be separated using Independent component analysis(ICA)

#### **Overview of Our Approach**



- Computing T that minimizes the correlation across different color channels.
- Repairing the corrupted channel using the cross-channel correlation.
- We reverse the transformation 3.

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## **Color Space Transformation**



where  $T = R(\phi)V$ . In order to find T effic  $\emptyset^* = \underset{\emptyset, C_i, C_j \in C}{\operatorname{argmin}} M(C_i(\emptyset), C_j(\emptyset))$ 

where  $M(C_1, C_2)$  is Kullback-Leibler [1] distance between image histograms H

 $\mathcal{M}(C_1, C_2) = \sum_{l_{C_1}, l_{C_2} \in \mathcal{L}} H(l_{C_1}, l_{C_2}) \log \frac{H(l_{C_1}, l_{C_2})}{H(l_{C_1})H(l_{C_2})}$ 

## **Constrained Hole Filling**

We repair  $\mathcal{C}_{\Omega}$  by minimizing  $\mathbf{1}_{w_{x,y}}(\mathcal{C}_{\Omega}(.$  $\arg\min_{\mathcal{C}_{\Omega}}\sum_{$  $\mathcal{C}^*_\Omega$   $x \in \Omega \ y \in N(x)$  $\lambda_1 \sum (\mathcal{C}_{\partial\Omega}(x) - \mathcal{C}_{\Omega}(x))^2 +$  $x \in \partial \Omega$ 

1 Structure constraint from intact channel 2 Boundary constraint (3) Prior distribution of colors

### **Discussion and limitations**

- Non-additive color model, e.g. watermark added digitally by multiplication
- Highly compressed images
- Identigram is not structure independent to background image
- Additional user segmentation is required for colorful identigram.

$$I'(x) = T[I(x)]$$

$$(x) - \mathcal{C}_{\Omega}(y))^{2} + \\ \stackrel{(3)}{+} \lambda_{2} \sum_{x \in \Omega \setminus \partial \Omega} (\mathcal{C}_{\partial \Omega}(x) - \mu_{g})^{2}$$

## **Experimental Results**













[1] T. M. Cover and J. A. Thomas. Elements of information theory. *Wiley, New York, 1991*. [2] M. Bertalmio, G. Sapiro, V. Caselles, and C. Ballester. Image inpainting. In SIGGRAPH, pages 417–424, 2000. [3] J. Jia and C.-K. Tang. Image repairing: Robust image synthesis by adaptive nd tensor voting. In CVPR, pages I: 643–650, 2003. [4] P. P'erez, M. Gangnet, and A. Blake. Poisson image editing. ACM Trans. Graph., 22:313–318, July 2003 [5] A. Criminisi, P. P´erez, and K. Toyama. Object removal by exemplar-based inpainting. In CVPR, 2003. [6] J. Mairal, M. Elad, and G. Sapiro. Sparse representation for color image restoration. *IEEE Trans. on Image Processing*, pages 53–69, 2007. [7] C. Zhou and S. Lin. Removal of image artifacts due to sensor dust. In CVPR, 2007.

