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A Data Set of Authentic and Spliced Image Blocks

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Abstract

Image splicing is a simple process that crops and pastes regions from the same or separate sources. It is a fundamental step used in digital photomontage, which refers to a paste-up produced by sticking together images using digital tools such as Photoshop. Examples of photomontages can be seen in several infamous news reporting cases involving the use of faked images. Searching for technical solutions for image authentication, researchers have recently started development of new techniques aiming at blind passive detection of image splicing. However, like most other research communities dealing with data processing, we need an open data set with diverse content and realistic splicing conditions in order to expedite the progresses and facilitate collaborative studies. In this report, we describe with details a data set of 1845 image blocks with a fixed size of 128 pixels x 128 pixels. The image blocks are extracted from images in the CalPhotos collection [CalPhotos'00], with a small number of additional images captured by digital cameras. The data set include about the same number of authentic and spliced image blocks, which are further divided into different subcategories (smooth vs. textured, arbitrary object boundary vs. straight boundary).

1 Introduction

Digital photomontage refers to a paste-up produced by sticking together images regions using digital tools such as Photoshop. It is a popular technique used in visual content creation as well as malicious faking of images [Mitchell'94]. Several recent notorious cases in the news reporting involve the publication of faked images that are created by photomontage, e.g., an image showing the joint presence of Jane Fonda and John Kerry, and an image showing the prisoner abuse by British soldiers. To deter such malicious efforts, we need a general solution that enables any party receiving a digital image to verify the content authenticity without any overhead of watermark insertion or signature generation at the source. Such a technical is called *blind*, *passive photomontage detection*. Specifically, we are concerned with the blind detection of image splicing – a simple cut-and-paste of image regions without any post-processing, which lies in the core of the photomontage operation.

Recently, several research groups have started the investigation of this problem and proposed the use of image signal statistics and machine learning methods [Farid'99, Farid'03, NgChang'04a, NgChang'04b, NgChang'04c]. Such efforts have shown promising results and research directions. In order for researchers to compare and evaluate the pros and cons of different approaches, an open benchmark data set is needed.

Our objective is to compile a data set open to the research community so that new discovery and development of technologies can be expedited. The current data set is collected with sample diversity in mind. It has 933 authentic and 912 spliced image blocks of size 128 x 128 pixels. The image blocks are extracted from images in CalPhotos image set [CalPhotos'00]. The data set can be greatly improved in many ways, and should be considered as a preliminary effort addressing the increasingly important topic of benchmarking.

2 Design Criteria

We emphasize the following points while creating the data set.

- Content diversity: The data set contains 1845 image blocks (128 x 128 pixels) of diverse content extracted from the images of CalPhotos site as well as a small set of 10 images captured by ourselves.
- Balanced distribution: The numbers of the authentic and spliced images are approximately the same.
- Realistic operation: We simulate the process of creating spliced images with two types of operations – crop-and-paste along object boundaries vs. crop-and-paste of horizontal (or vertical) strips. Image objects and strips can be from the same image or two separate source images. Objects spliced together can be the same or different types – smooth or textured.
- Localized detection: We decompose the authentic as well as spliced images into separate local blocks of a fixed size (128 pixels x 128 pixels). The block is kept

at a reasonable size to ensure that sufficiently accurate statistical features can be estimated using the empirical data of each block.

3 Copyright and Download URL

We thank the Berkeley Digital Library group for their generous support in making the original image set available for internal research. We are currently trying to seek the permissions from the prospective owners of the images for us to release the data set as a research benchmark. Status of such permissions and information about download procedures will be updated on the following site.

http://www.ee.columbia.edu/dvmm/downloads/AuthSplicedDataSet/AuthSplicedDataSet.htm

4 The Structure of the Data Set

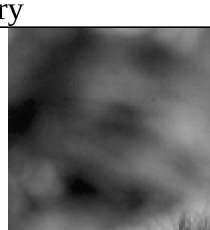
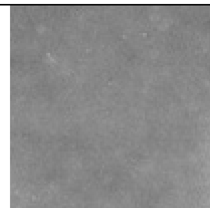
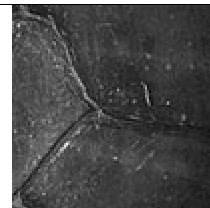
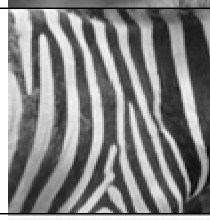
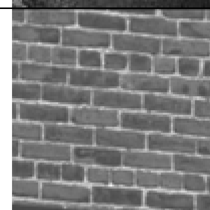
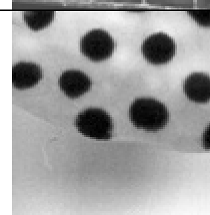
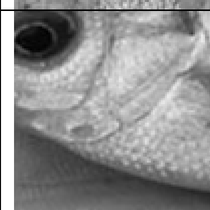
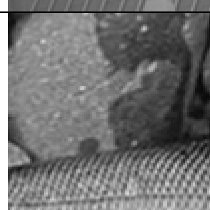
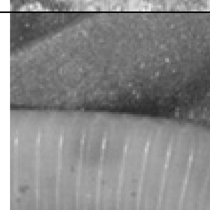
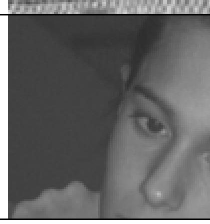
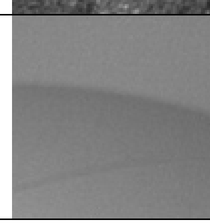
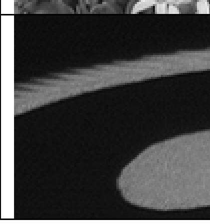
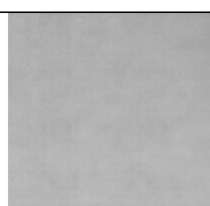
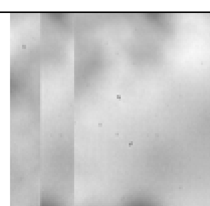
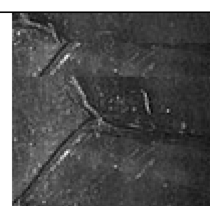
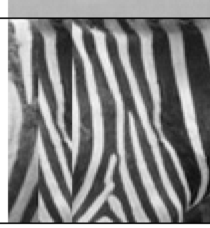
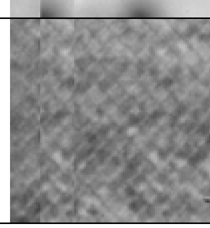
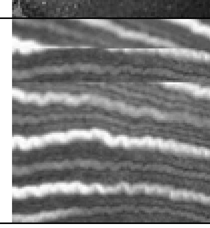
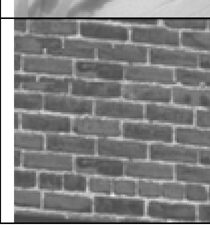
The data set consists of 1845 image blocks of size 128x128 pixels.

There are two main categories of data set:
(Au) – Authentic category: 933 image blocks
(Sp) – Spliced category: 912 image blocks

The Authentic and Spliced categories are respectively subdivided in five subcategories:
(T) – Image block with an entirely homogeneous textured region
(S) – Image block with an entirely homogeneous smooth region
(TS) – Image block with an object boundary between a textured region and a smooth region
(TT) – Image block with an object boundary between two textured regions
(SS) – Image block with an object boundary between two smooth regions

Then, the subcategories (TS), (TT) and (SS) is further subdivided into 3 sub-subcategories, according to the orientation of the object boundary:
(V) – with vertical object boundary
(H) – with horizontal object boundary
(O) – other than (V) and (H)

Below are the some typical image blocks in each subcategory of the data set:

Authentic Category				
Homogenous Smooth				
Homogenous Textured				
Textured-Smooth				
Textured-textured				
Smooth-smooth				
Spliced Category				
Homogenous Smooth				
Homogenous Textured				

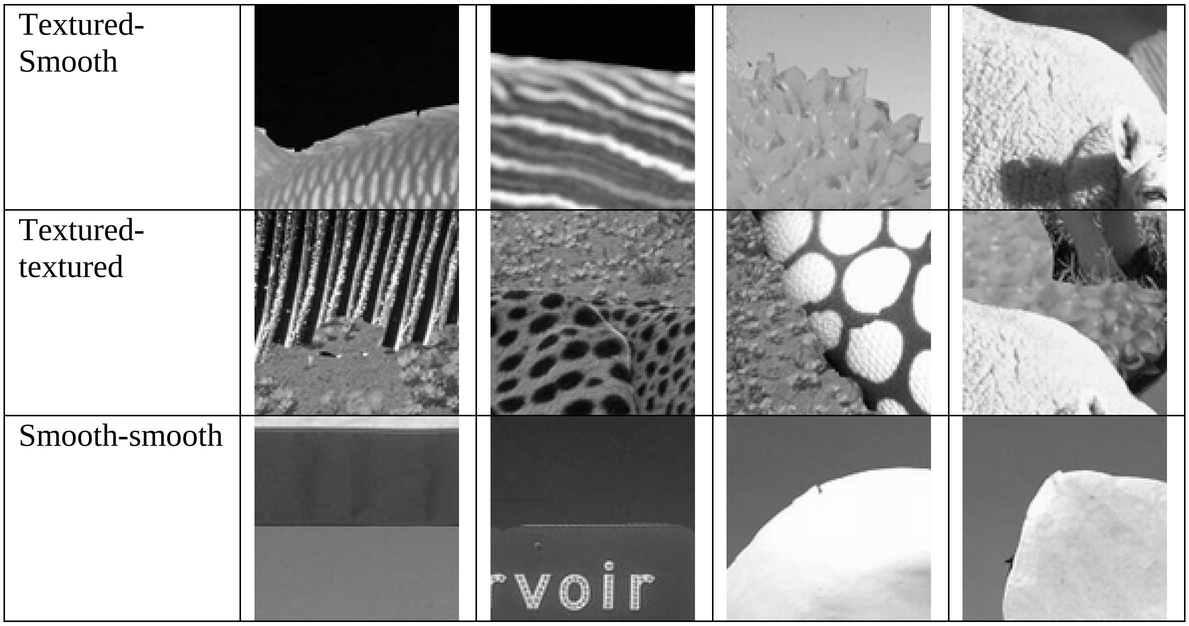


Figure 1 Typical image blocks in the data set

The following table shows that the number of image blocks in each subcategory:

Table 1: numbers of image blocks in different subcategories

Category	One Textured Background (T)	One Smooth Background (S)	Textured-Smooth Interface (TS)	Textured-texture Interface (TT)	Smooth-smooth Interface (SS)
Authentic (Au)	126	54	409	179	165
Spliced (Sp)	126	54	298	287	147

5 Class Notation and File Structure

A sub-subcategory is named as a class. We denote a particular class with the following naming convention:

(main-categories)-(sub-categories)-(orientation)

(e.g.) A class under the *authentic* categories, with image blocks of having a *vertical* object boundary separating a *textured* and a *smooth* region is denoted as Au-TS-V class.

(e.g.) A class under the *spliced* categories, with image blocks of an entirely *homogeneous textured* region is denoted as Sp-T class.

Each class of image blocks is kept a directory with the same name as its class name within the zip file.

6 Image Sources

The original images used in this dataset consist of 312 images from CalPhotos collection and 10 images captured by us using a digital camera.

We considered images that come directly out of imaging devices as authentic and images resulted from splicing of image regions (of the same or different images) as spliced. More discussions and definitions of image authenticity can be found in [NgChang'04a].We made an assumption that images from the CalPhotos site are the original captured data from imaging devices (cameras or scanners) without editing or post-processing. However, this assumption has not been confirmed with the original image providers.

The following table lists the IDs of the images from the CalPhotos Images. CalPhotos images are originally organized in directory structure with the directory name being number code.

Table 2: IDs of images from the CalPhotos image collection.

Directory	Images ID	No of Images
0162_2013\0556	All (86 images)	86
0000_0000\0101	All (172 images)	172
0000_0000\0001	All (3 images)	3
0000_0000\0201	0023, 0057, 0058, 0126, 0122, 0125	6
0000_0000\0301	0064, 0127	2
0000_0000\0401	0012, 0021	2
0000_0000\0600	0007	1
0000_0000\0716	0001	1
0000_0000\0800	0099, 0125, 0166, 0177	4
0000_0000\0999	0003, 0016, 0012	3
0000_0000\1000	0220, 0358, 0362, 0383, 0389, 0437	6
0000_0000\1100	0046	1
0000_0000\1200	0254, 0258	2
0024_3291\1997	0015, 0016, 0023, 0063, 0070, 0088, 0095, 0097, 0137	9
0024_3291\1998	0136	1
0072_3301\1163	0134	1
0215	0040	1
1618	0007	1
1622	0038, 0063	2
1626	0010, 0011, 0012	3
1878	0064, 0065, 0066	3
1111_1111\1111	0007, 0181	2
	Total	**312**

To further diversify the image types, we use a digital camera to capture 10 additional images. Specifically, we mainly use this small set of images to populate more image blocks for Au-SS-V/O and Au-TS-H/V/O classes, as shown in Table 3, where more detailed information about the 10 digital images are given Table 3. Besides that, Figure 2 shows two examples of the digital images.

Table 3: Characteristics of the 10 digital images captured by using a digital camera

Model of the camera	Canon PowerShot S40
Image size	1600 x 1200
Image format	Jpeg
Image blocks generated from the 10 images	Au-SS-O (blk_11_57.bmp - blk_11_76.bmp) Au-SS-V (blk_10_32.bmp - blk_10_36.bmp) Au-TS-H (blk_3_86.bmp - blk_3_110.bmp) Au-TS-O (blk_5_138.bmp -blk_5_163.bmp) Au-TS-V (blk_4_58.bmp - blk_4_95.bmp) Au-TT-O (blk_8_77.bmp - blk_8_78.bmp) Au-TT-V (blk_7_22.bmp - blk_7_32.bmp)

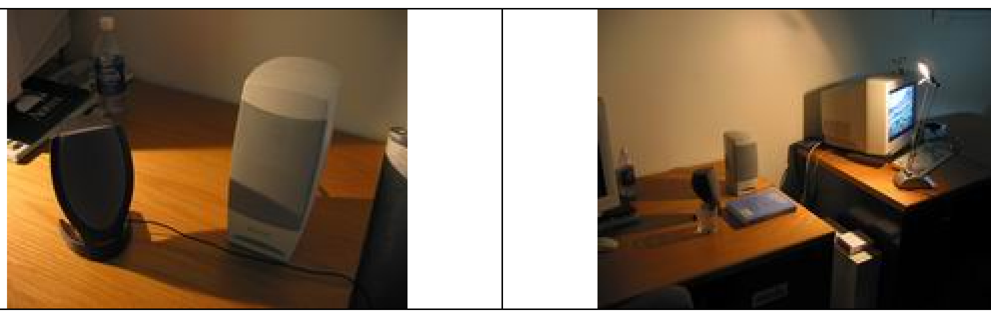


Figure 2: Examples from the 10 images that we took and used for generating image blocks in the data set

7 The procedure for producing the data set

In this section, we describe the procedures used in generating the authentic and spliced image blocks.

For the authentic category, the image blocks are cropped directly from the CalPhotos images and the images captured by the camera without any further manipulations.

For the spliced category, we first create composite images by object-based image splicing, i.e., cropping an object from an image and paste it to another image, without any post-processing such as edge smoothing and so on. Then, we cropped image blocks which contains part of the splicing boundary from the composite image as image blocks of the (Sp-TS-x), (Sp-TT-x) and (Sp-SS-x) classes, where x represents V, H or O. The above-mentioned cut and paste of image objects is performed using Adobe Photoshop 6.0 on a Windows XP. When cutting an object from an image, the outline of the object is traced using the Magnetic Lasso tool. Plain cut and paste commands are used for transforming the cut object to another image.

The image blocks of (Sp-T) and (Sp-S) classes (i.e., spliced image blocks of homogenous textured and smooth region) are created from the corresponding image blocks of (Au-T) and (Au-S) classes (i.e., authentic image blocks of homogenous textured and smooth region) respectively. Specifically, given an image block of (Au-T) or (Au-S) class, a corresponding image block for (Sp-T) or (Sp-S) class respectively is produced, by copying a vertical strip or a horizontal strip of 20 pixels wide (the decision on the strip orientation is random) from a randomly selected location, within the given image block of (Au-T) or (Au-S) class, and paste it to another randomly selected but different location within the same image (see Figure 3). The rationale for such way of producing images blocks of (Sp-T) and (Sp-S) classes from image blocks of (Au-T) and (Au-S) classes is for imitating the likely scenario of image forger patching up the void left behind after removing an object from an image. In this case, the void is likely to be covered up using small patches similar to the homogenous background. (Note that (Au-T) and (Au-S) classes consist of image blocks with homogenous texture or homogenous smooth region).

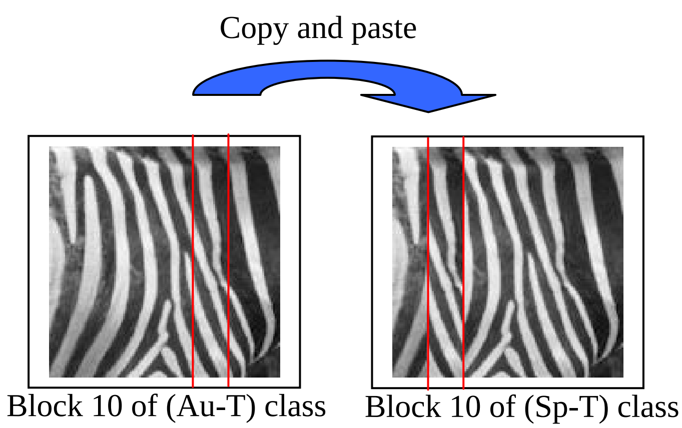


Figure 3: The process for creating image blocks of (Sp-T) and (Sp-S) classes from the corresponding image blocks of (Au-T) and (Au-S) classes respectively: An example of creating the image block no. 10 of (Sp-T) from the image block no. 10 of (Au-T)

8 Questions and Comments

Please forward any questions and comments to Tian-Tsong Ng (ttng@ee.columbia.edu) or Shih-Fu Chang (sfchang@ee.columbia.edu)

9 Acknowledgements

We sincerely appreciate Ginger Ogle of Berkeley Digital Library Project for the help in contacting the original photographers and transferring the image files.

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