Detecting Fakes

Bernadette by Stephen Molyneaux

Computational Photography
Derek Hoiem, University of Illinois

http://www.flickr.com/photos/kjmeow/2320759046/
• Will grade midterm by next Tues

• Remember to complete your project 5 by Mon night
Detecting Fakes

1. Detecting photorealistic graphics

2. Detecting manipulated images
CG vs. Real: Can you do it?

- [link](http://area.autodesk.com/fakeorfoto/challenge)

- I got 2 out of 12 right
  - Last year, I got 3/12
  - Chance = 6 out of 12
CG vs. Real -- Why It Matters: Crime

• 1996 Child Pornography Prevent Act made certain types of “virtual porn” illegal

• Supreme court over-ruled in 2002

• To prosecute, state needs to prove that child porn is not computer-generated images
Automatically Detecting CG

• Sketch of approach
  – Intuition: natural images have predictable statistics (e.g., power law for frequency); CG images may have different statistics due to difficulty in creating detail
  – Decompose the image into wavelet coefficients and compute statistics of these coefficients

Lyu and Farid 2005: “How Realistic is Photorealistic?”
2D Wavelets

Kind of like the Laplacian pyramid, except broken down into horizontal, vertical, and diagonal frequency

Laplacian Pyramid

Wavelet Pyramid
2D Wavelet Transform

Illustration of procedure

Wavelet decomposition of disc image

Figure from Lyu and Farid 2005: “How Realistic is Photorealistic?”
Automatically Detecting CG

• Sketch of approach
  – Intuition: natural images have predictable statistics (e.g., power law for frequency); CG images may have different statistics due to difficulty in creating detail
  – Decompose the image into wavelet coefficients and compute statistics of these coefficients
  – Train a classifier to distinguish between CG and Real based on these features
    • Train RBF SVM with 32,000 real images and 4,800 fake images
    • Real images from http://www.freefoto.com
    • Fake images from http://www.raph.com and http://www.irtc.org/irtc/

Lyu and Farid 2005: “How Realistic is Photorealistic?”
Results

• 98.8% test accuracy on real images
• 66.8% test accuracy on fake images
• 10/14 on fakeorfoto.com

Lyu and Farid 2005: “How Realistic is Photorealistic?”
Results

• Fake-or-photo.com: Correct
Results

• Fake-or-photo.com: Wrong

Photos misclassified as CG

CG misclassified as photos

Lyu and Farid 2005: “How Realistic is Photorealistic?”
Results

• Fakes, confidently labeled as fake

Lyu and Farid 2005: “How Realistic is Photorealistic?”
Results

• Fake images thought to be real

Lyu and Farid 2005: “How Realistic is Photorealistic?”
Results

- Real photographs, confidently labeled as real

Lyu and Farid 2005: “How Realistic is Photorealistic?”
Results

• Real photos, incorrectly thought to be fake

Lyu and Farid 2005: “How Realistic is Photorealistic?”
Detecting Forgery: Can You Do It?


• I got 5/10 (6/10 last year)
  – Chance = 5/10
Detecting Forgery -- Why It Matters: Trust

Examples collected by Hany Farid: http://www.fourandsix.com/photo-tampering-history/

Iconic Portrait of Lincoln (1860)
“While photographs may not lie, liars may photograph.”

Lewis Hine (1909)
Mussolini in a Heroic Pose (1942)
1950: Doctored photo of Senator Tydings talking with Browder, the leader of the communist party, contributed to Tydings’ electoral defeat
Pulitzer Prize winning photograph of Kent State killing (1970)
Gang of Four are removed (1976)
1989 composite of Oprah and Ann-Margret (without either’s permission)
Photo from terrorist attack in 1997 in Hatshepsut, Egypt
Caption: “Actress and Anti-war activist Jane Fonda speaks to a crowd of Vietnam veterans, as activist and former Vietnam vet John Kerry listens and prepares to speak next concerning the war in Vietnam.” (AP Photo)
2005: Pres Bush scribbles a note to C. Rice during UN Security Council Meeting
2005: USA Today SNAFU
2006: “Women you will never see in Maxim” – movie star Khushboo’s head on a model’s body; Maxim got sued.
2006: Photo by Adnan Hajj of strikes on Lebanon (original on right)
Later, all of Hajj’s photos were removed from AP and a photo editor was fired.
2007 Retouching is “completely in line with industry standards”
2007: Zhou Zhenglong claimed to take 71 photos of the nearly extinct South China tiger.
Similar scandal in 2011 from Terje Helleso who won Swedish Env. Prot. award
2008 Ad against Myers. Myers says he’s never met Bush.
2009: Digital diversity
“Evidence” that Malaysian politician Jeffrey Wong Su En was knighted by the Queen (2010)
Cloning sand to remove shadow. Miguel Tovar – banned from AP, all his photos removed (2011)
Photo from Korean Central News Agency, determined to be composite (people don’t appear wet) – was attempt to get sympathy for North Korea to get more international aid
Detecting forgeries

• Work by Hany Farid and colleagues
• Method 1: 2D light from occluding contours
Estimating lighting direction

Method 1: 2D direction from occluding contour

• Provide at least 3 points on occluding contour (surface has 0 angle in Z direction)
• Estimate light direction from brightness
Estimating lighting direction
Estimating lighting direction

• Average error: 4.8 degrees
Method 2: Light from Eyes

Farid – “Seeing is not believing”, IEEE Spectrum 2009
Estimating Lighting from Eyes
Method 3: Complex light with spherical harmonics

- Spherical harmonics parameterize complex lighting environment
- Same method as occluding contours, but need 9 points
Method 3: Complex light with spherical harmonics
Method 4: Demosaicking Prediction

• In demosaicking, RGB values are filled in based on surrounding measured values
• Filled in values will be correlated in a particular way for each camera
• Local tampering will destroy these correlations
Demosaicking prediction

- **Upside:** can detect many kinds of forgery
- **Downside:** need original resolution, uncompressed image

![Original](image1)
![Tampered](image2)

**Error in pixel prediction from a linear interpolation**

![FFT of error in each window](image3) (periodic for untampered case)
Method 5: JPEG Ghosts

• JPEG compresses 8x8 blocks by quantizing DCT coefficients to some level
  – E.g., coefficient value is 23, quantization = 7, quantized value = 3, error = 23-21=2
• Resaving a JPEG at the same quantization will not cause error, but resaving at a lower *or higher* quantization generally will
  – Value = 21; quantization = 13; error = 5
  – Value = 21; quantization = 4; error = 1

Farid: “Photo Fakery and Forensics” 2009
JPEG Ghosts

- Original is saved at 85 quality, center square is cut out and compressed at 65 quality; then image is resaved at given qualities

Pixel error for image saved at various JPEG qualities
JPEG Ghosts

- If there is enough difference between the quality of the pasted region and the final saved quality, the pasted region can be detected with high accuracy.

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JPEG Ghosts

Pixel error for manipulated image saved at various JPEG qualities
JPEG Ghosts

Pixel error for manipulated image saved at various JPEG qualities
Summary

• Digital forgeries are an increasingly major problem as it becomes easier to fake images

• A variety of automatic and semi-automatic methods are available for detection of well-done forgeries
  – Checking lighting consistency
  – Checking demosaicking consistency (for high quality images)
  – Checking JPEG compression level consistency (for low quality images)
Next week

• Image-based lighting