Image Forensics: Detecting Forged Photos





from *The Onion*

Photos and slides from H. Farid, L. Lazebnik, D. Hoiem

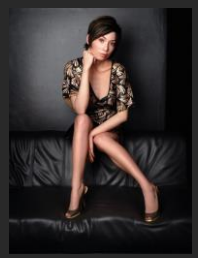
Detecting Fakes

1. Detecting photorealistic graphics
2. Detecting manipulated images

Photo manipulation is the application of image editing techniques to photographs in order to create an illusion or deception (in contrast to *enhancement* or *correction*), through analog or digital means

Fake or Real?

- http://area.autodesk.com/fakeorfoto/
- http://www.life.com/archive/realfake



CG



Real

Detecting CG images can be done quite well by decomposing image into wavelet coefficients and using these features for classification

CG vs. Real – Why?

- 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



Real Photo



CG

Automatically Detecting CG

- Basic Idea
  - 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?"

Photo Manipulation for Aesthetics



Airbrushing and retouching to enhance appearance

2007: Retouching is "completely in line with industry standards"







Because of retouching, Reese Witherspoon's appearance changes drastically from magazine cover to cover

Source: New York Times, May 2009



Andy Roddick, May 2007

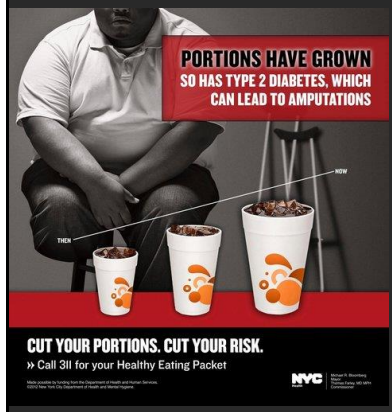


Before and After Retouching Examples



1989 composite of Oprah and Ann-Margret (without either's permission)

Photo Manipulation for Government Campaigns

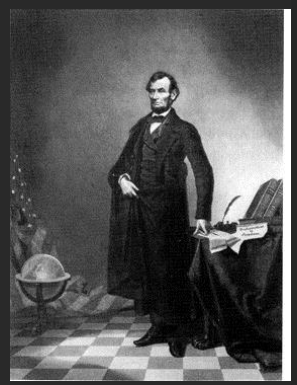




NYC poster shows man who supposedly lost his leg to diabetes, though original image is on right. Source: New York Times, 1/25/2012

A Long History of Photo Manipulation

Examples collected by Hany Farid: http://www.cs.dartmouth.edu/farid/research/tampering.html



Iconic Portrait of Lincoln (1860)

Photo Manipulation as Art





Sarolta Ban

Photo Manipulation in Journalism



General Grant in front of Troops (1864)



Mussolini in a Heroic Pose (1942)

Photo Manipulation in Journalism

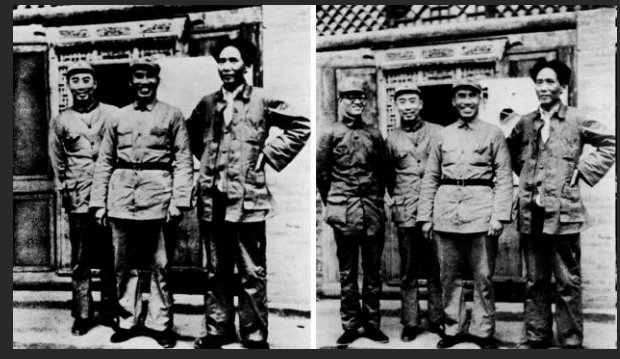
1930s: Stalin had disgraced comrades airbrushed out of his pictures



http://www.newseum.org/berlinwall/commissar_vanishes/index.htm

http://www.cs.dartmouth.edu/farid/research/digitaltampering/

1936: same with Mao



http://www.cs.dartmouth.edu/farid/research/digitaltampering/



Pulitzer Prize winning photograph of Kent State killing (1970)



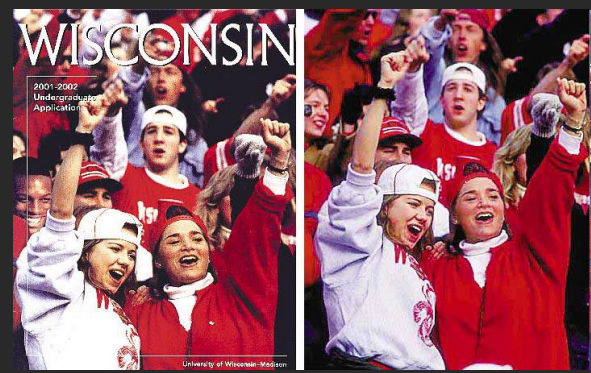
2008

1994: O.J. Simpson's mug shot modified to appear more menacing



http://www.cs.dartmouth.edu/farid/research/digitaltampering/

2000: black student's face inserted into UW magazine



http://www.cs.dartmouth.edu/farid/research/digitaltampering/

2003: This digital composite of a British soldier in Basra, gesturing to Iraqi civilians urging them to seek cover, appeared on the front page of the Los Angeles Times shortly after the U.S. led invasion of Iraq. Brian Walski, a staff photographer for the Los Angeles Times and a 30-year veteran of the news business, was fired after his editors discovered that he had combined two of his photographs to "improve" the composition.



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2004: Composite of John Kerry and Jane Fonda



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2004: Composite of John Kerry and Jane Fonda



Kerry at Rally for Peace 1971

Fonda at rally in 1972

http://www.cs.dartmouth.edu/farid/research/digitaltampering/

2006: This photograph by Adnan Hajj, a Lebanese photographer, showed thick black smoke rising above buildings in the Lebanese capital after an Israeli air raid. The Reuters news agency initially published this photograph on their web site and then withdrew it when it became evident that the original image had been manipulated.



http://www.cs.dartmouth.edu/farid/research/digitaltampering/

2008: This photograph, by Liu Weiqiang of the Daqing Evening News, won an award for "one of the ten most impressive news photos of 2006". This photograph was recently revealed to be a composite of two separate photographs: the antelopes and the train.



http://www.cs.dartmouth.edu/farid/research/digitaltampering/

Forggensee Panorama



Composite from 16 photos

Detecting Digital Tampering: Cloning

- **Exposing Digital Forgeries by Detecting Duplicated Image Regions**
  - A.C. Popescu and H. Farid
  - Technical Report, TR2004-515, Dartmouth College, Computer Science



Detecting Digital Tampering: Lighting

- **Exposing Digital Forgeries by Detecting Inconsistencies in Lighting**
  - M.K. Johnson and H. Farid
  - ACM Multimedia and Security Workshop, New York, NY, 2005



Detecting Digital Tampering: Lighting

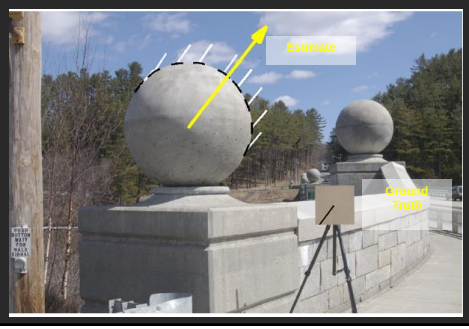
- **Exposing Digital Forgeries by Detecting Inconsistencies in Lighting**
  - M.K. Johnson and H. Farid
  - ACM Multimedia and Security Workshop, New York, NY, 2005



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



Detecting Inconsistencies in Lighting

Fake photo



Real photo



Lighting: Specular Highlights in Eyes

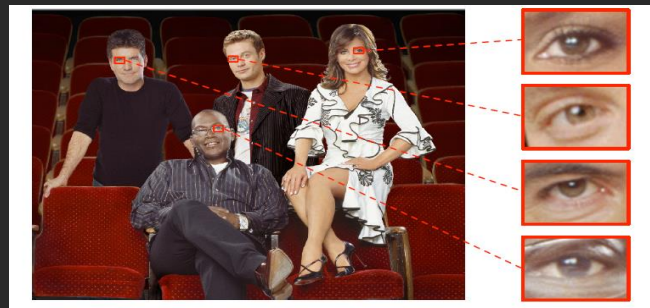
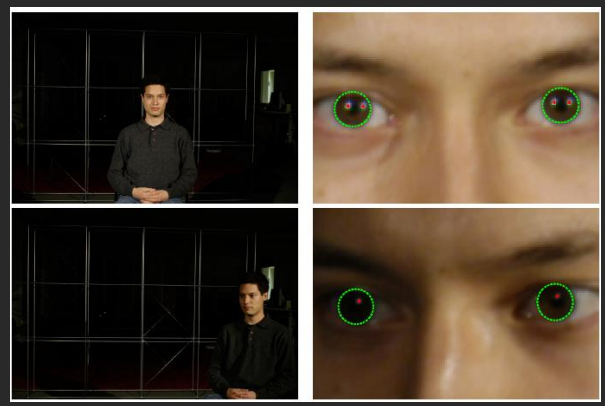


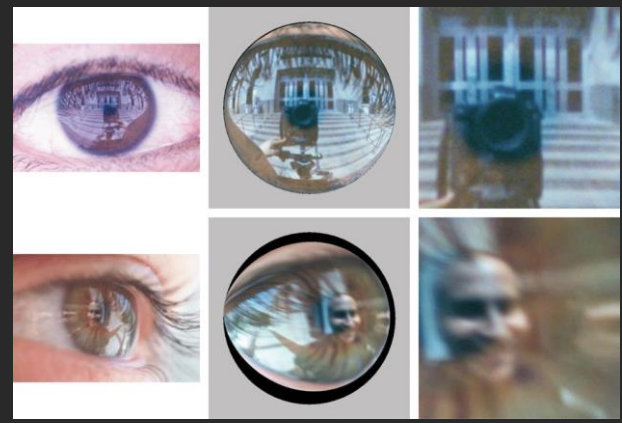
Fig. 1. This photograph of the *American Idol* host and judges is a digital composite of multiple photographs. The inconsistencies in the shape and position of the specular highlight on the eyes suggest that these people were originally photographed under different lighting conditions. Photo courtesy of Fox News and the Associated Press.

M.K. Johnson and H. Farid, **"Exposing Digital Forgeries Through Specular Highlights on the Eye,"** 9th International Workshop on Information Hiding, 2007

Estimating Lighting from Eyes



Seeing the Environment Reflected in the Eye

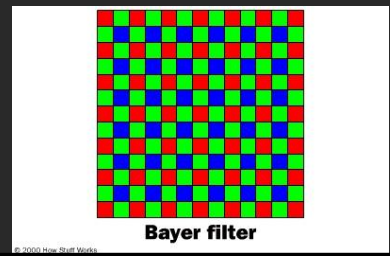


Nishino and Nayar, 2004

Watching a Bus

Method 3: Demosaicing Prediction

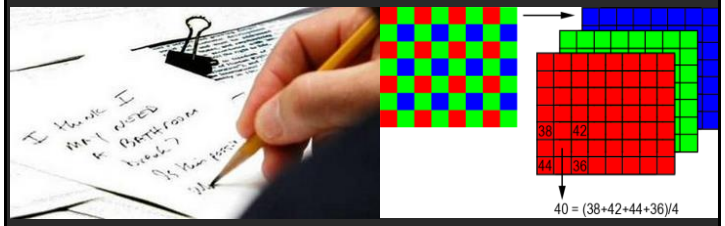
- In demosaicing, RGB values are filled in based on surrounding measured values
- Filled in values will be **correlated** in a particular way for each camera
- Local tampering will destroy these correlations



Farid: "Photo Fakery and Forensics" 2009

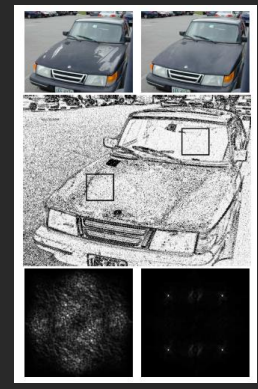
Demosaicing Prediction

- **Exposing Digital Forgeries in Color Filter Array Interpolated Images**
  - A.C. Popescu and H. Farid
  - IEEE Transactions on Signal Processing, 53(10):3948-3959, 2005



Demosaicing Prediction

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



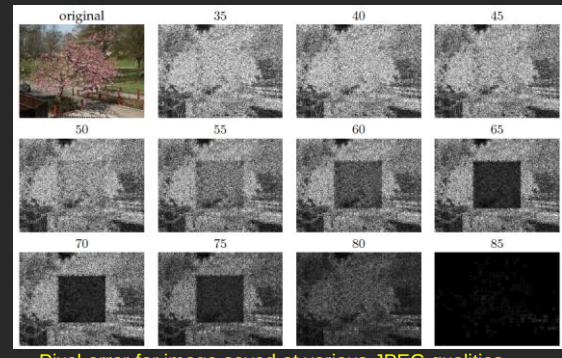
Method 4: JPEG Ghosts

- 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 has square cut out and compressed to quality 65, then reinserted



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

Table 2: JPEG ghost detection accuracy (%)

size	$Q_1 - Q_0$ 0	5	10	15	20	25
200×200	99.2	14.8	52.6	88.1	93.8	99.9
150×150	99.2	14.1	48.5	83.9	91.9	99.8
100×100	99.1	12.6	44.1	79.5	91.1	99.8
50×50	99.3	5.4	27.9	58.8	77.8	97.7

JPEG Ghosts

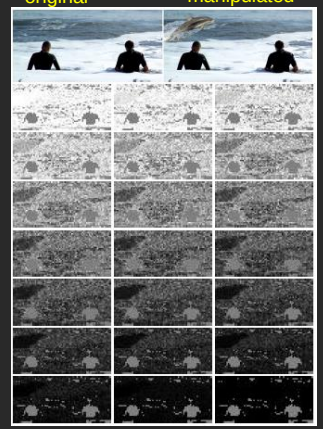
original manipulated



Pixel error for manipulated image saved at various JPEG qualities

JPEG Ghosts

original manipulated



Pixel error for manipulated image saved at various JPEG qualities

Conclusions

- Digital forgeries are an increasingly important 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 demosaiccing consistency (for high quality images)
  - Checking JPEG compression level consistency (for low quality images)