Detecting Fakes

Bernadette by Stephen Molyneaux

http://www.flickr.com/photos/kjmeow/2320759046/

Computational Photography

Derek Hoiem, University of Illinois

Project 4 results: notable projects

http://xle2.web.engr.illinois.edu/cs445/proj4/: great before/after visualizations

http://lavisha2.web.engr.illinois.edu/cs445/proj4/: Nice Project, Tone Mapping Results

http://shubham9.web.engr.illinois.edu/cs445/proj4/: Photographer Removal

http://mfalota2.web.engr.illinois.edu/cs445/proj4/: use of mirrors in the rendering

http://damir2.web.engr.illinois.edu/cs445/proj4/

- Nice renderings and panoramic transformations

http://gluo2.web.engr.illinois.edu/cs445/proj4/ and http://hoyinau2.web.engr.illinois.edu/cs445/proj4/

- Portal Weighted Companion Cube Rendering

http://schen149.web.engr.illinois.edu/cs445/proj4/ and http://xle2.web.engr.illinois.edu/cs445/proj4/

- Nice project pages with high resolution images

http://jtang38.web.engr.illinois.edu/cs445/proj4/ and http://blim7.web.engr.illinois.edu/cs445/proj4/

- Nice results testing multiple objects and parameters and Tone Mapping looks nice

http://jdrynld2.web.engr.illinois.edu/cs445/proj4/ and http://vjdixit2.web.engr.illinois.edu/cs445/proj4/

- Nice renderings and Panoramic transformations

http://cshen19.web.engr.illinois.edu/cs445/proj4/ and http://xwu68.web.engr.illinois.edu/cs445/proj4/

- Nice website and presentation, nice results, and nice photographer removal!

http://xshi27.web.engr.illinois.edu/cs445/proj4/

- Only person that successfully completed all extra credit parts

http://dsun18.web.engr.illinois.edu/cs445/proj4/

- nice website, results, and tone mapping

Detecting Fakes

1. Detecting photorealistic graphics

2. Detecting manipulated images

CG vs. Real: Can you do it?

- http://area.autodesk.com/fakeorfoto/
- I got 4 out of 10 right

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

Real Photo

CG

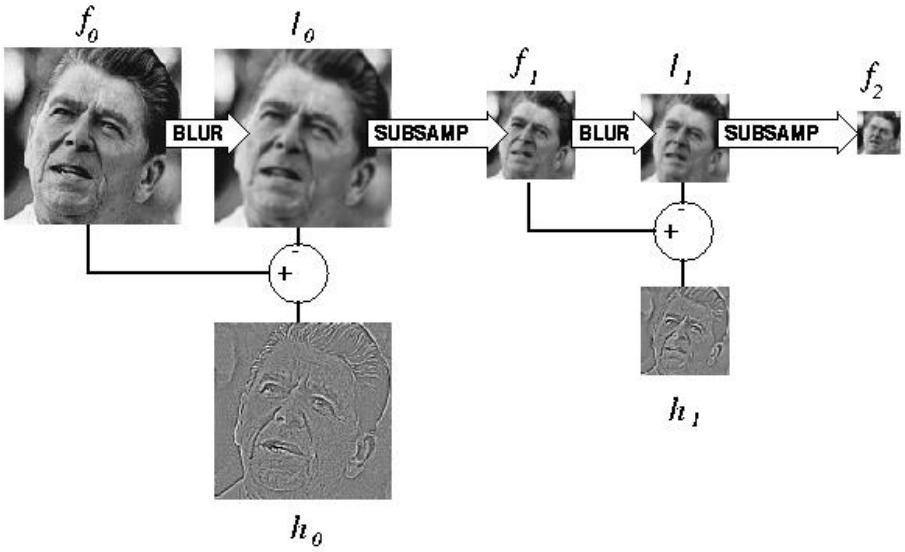
Automatically Detecting CG

- 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

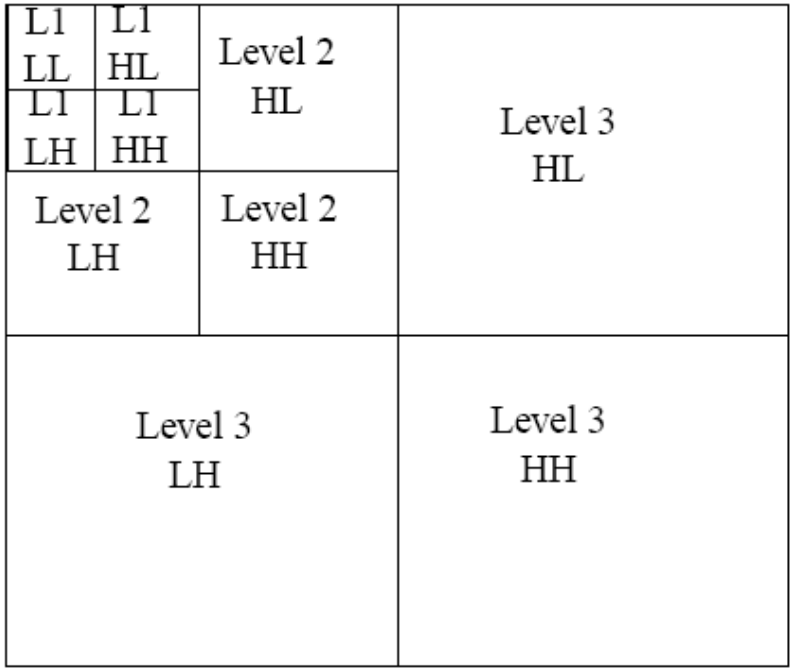
Lyu and Farid 2005: “How Realistic is Photorealistic?”

2D Wavelets

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



Laplacian Pyramid



Wavelet Pyramid

2D Wavelet Transform

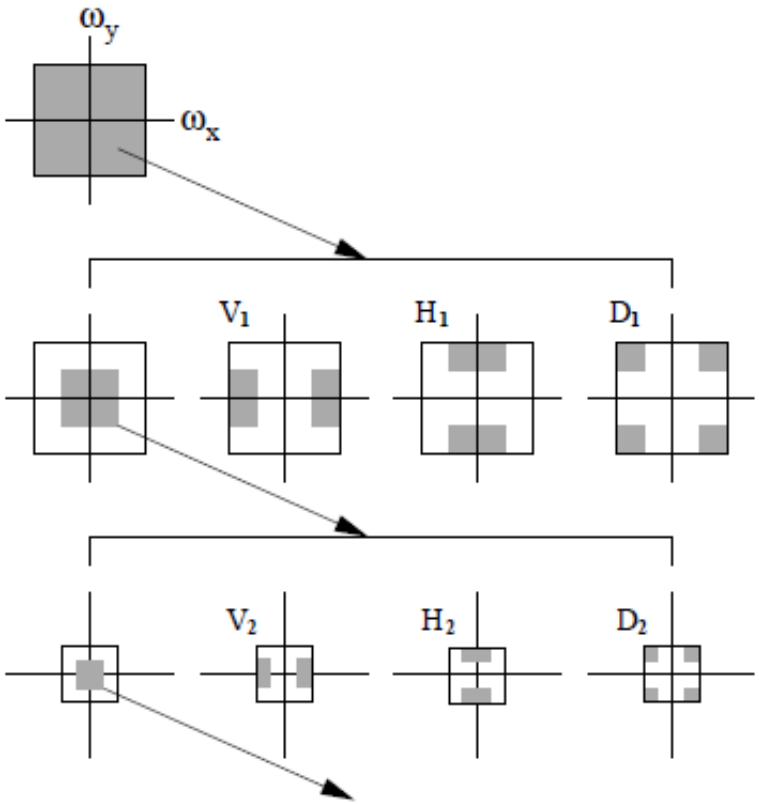
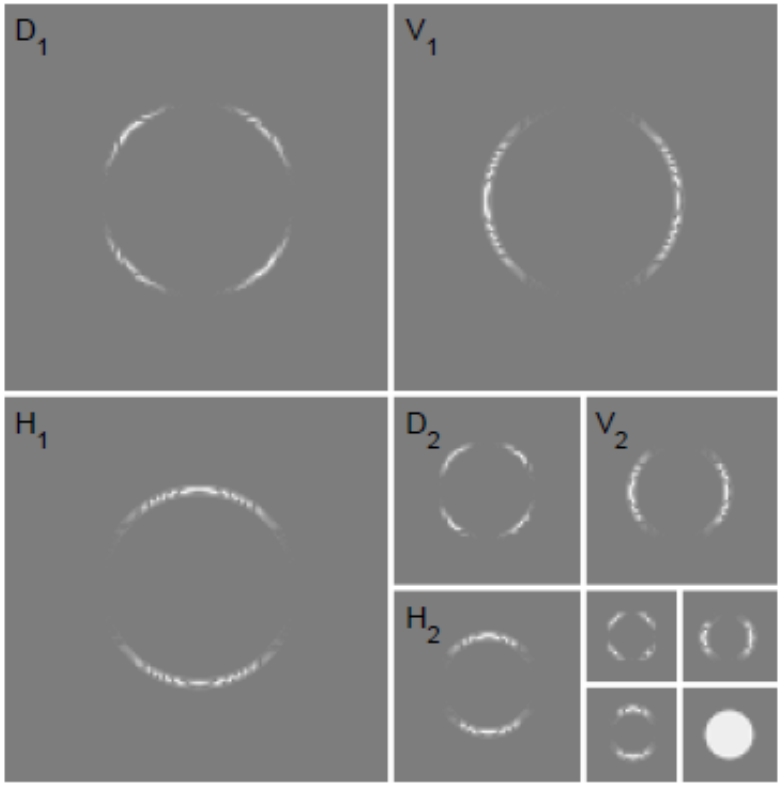


Illustration of procedure



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

Real Photos

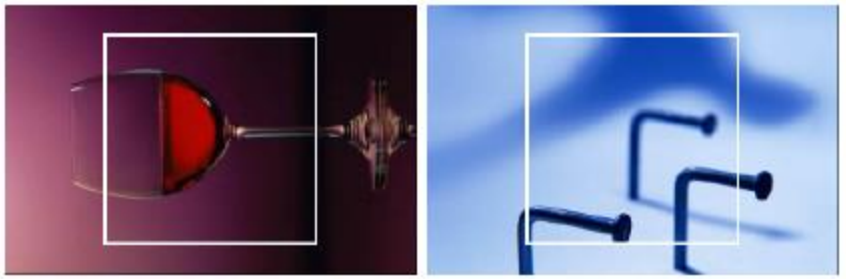
CG

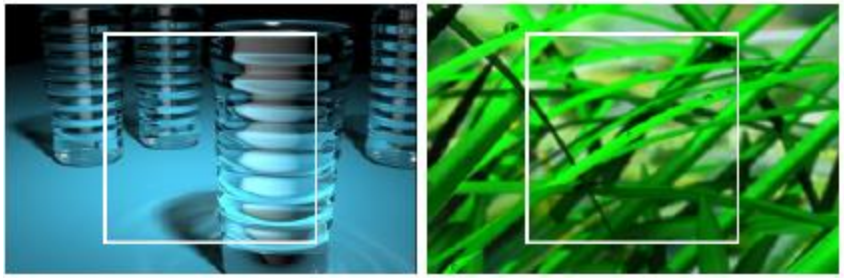
Lyu and Farid 2005: “How Realistic is Photorealistic?”

Results

- Fake-or-photo.com: Wrong

Real photos misclassified as CG





CG misclassified as real 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?”

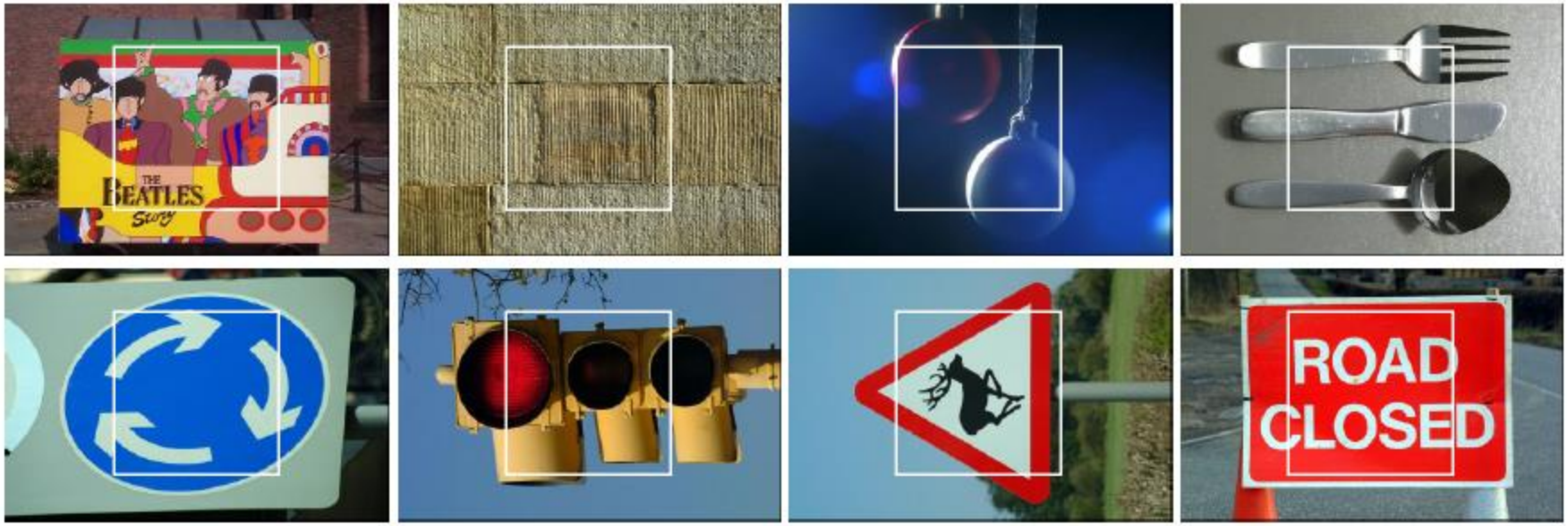
Results

- 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?”

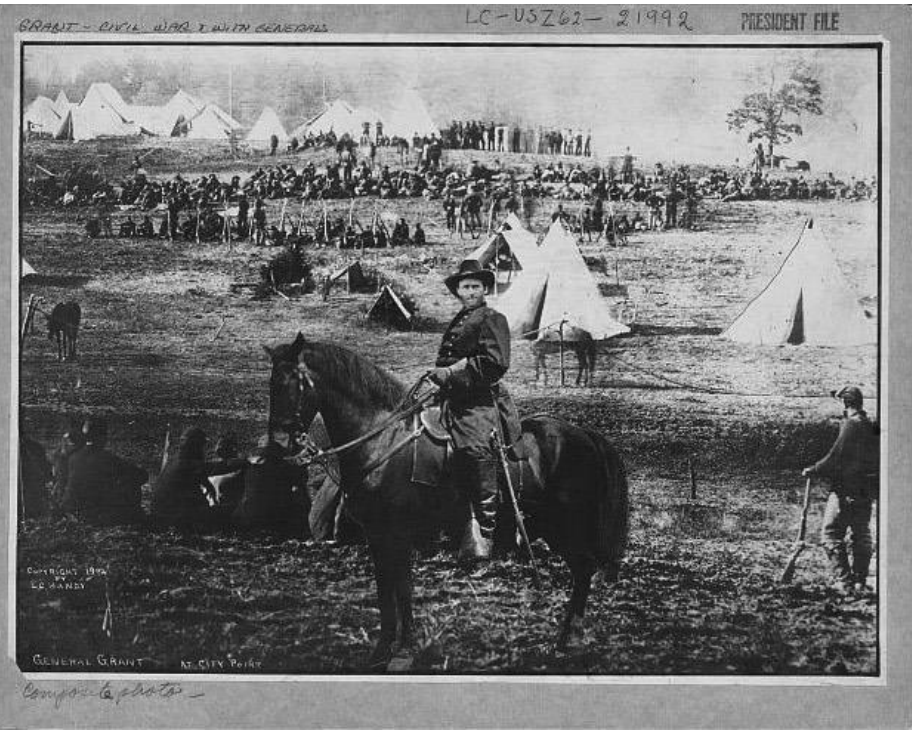
Detecting Forgery -- Why It Matters: Trust

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)

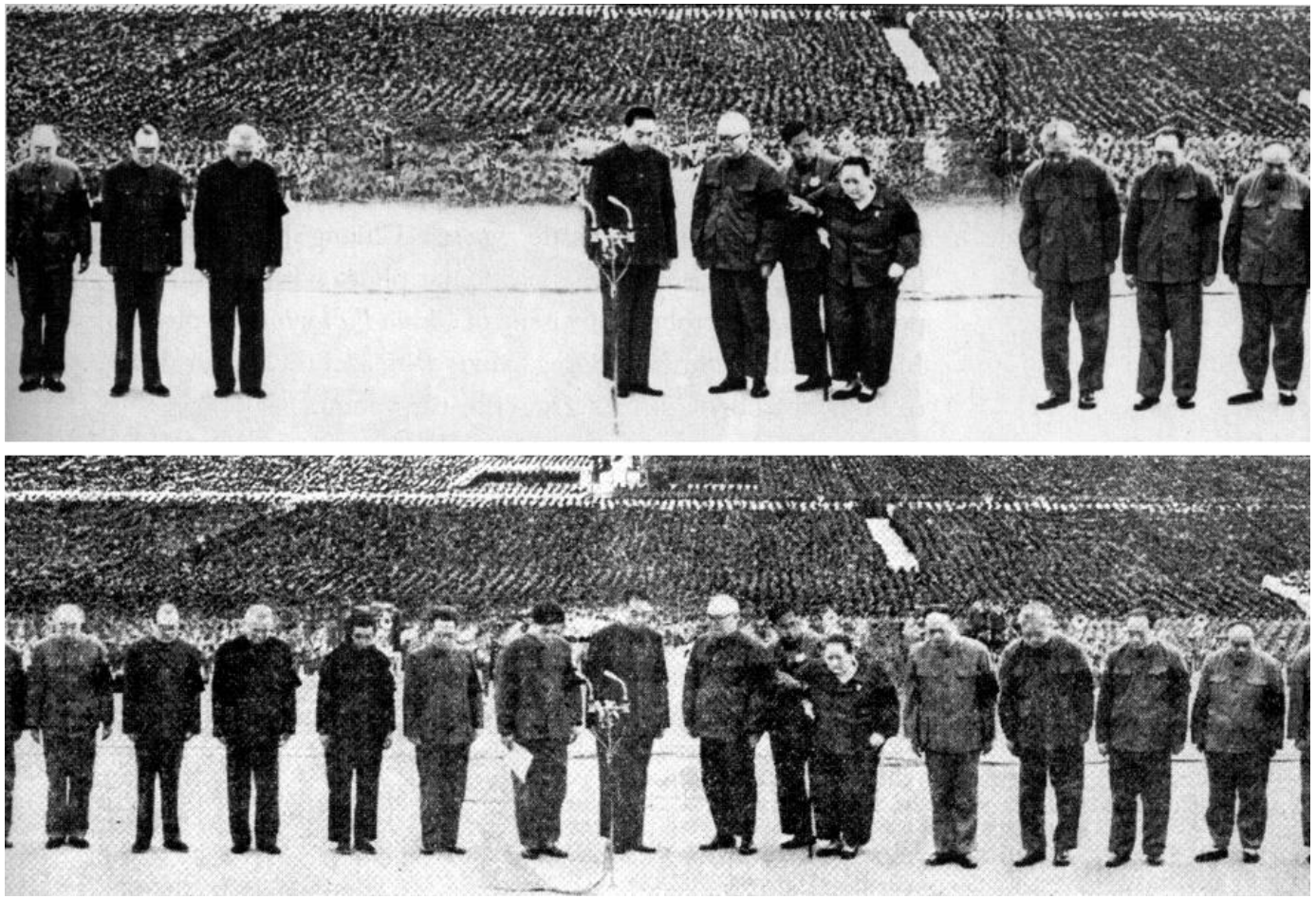


General Grant in front of Troops (1864)

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)

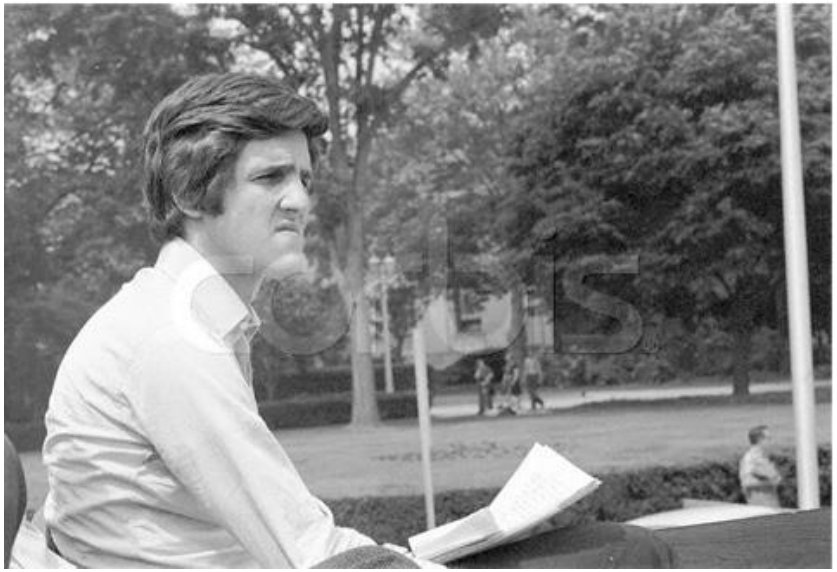


Gang of Four are removed (1976)

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)



Kerry at Rally for Peace 1971

Fonda at rally in 1972

2005: Pres Bush scribbles a note to C. Rice during UN Security Council Meeting

2005: USA Today SNAFU

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”

2013: Fake fattening

The French Magazine Paris Match altered a photograph of French President Nicolas Sarkozy by removing some body fat. (2007)

Claimed Photo

Poster

Overlay

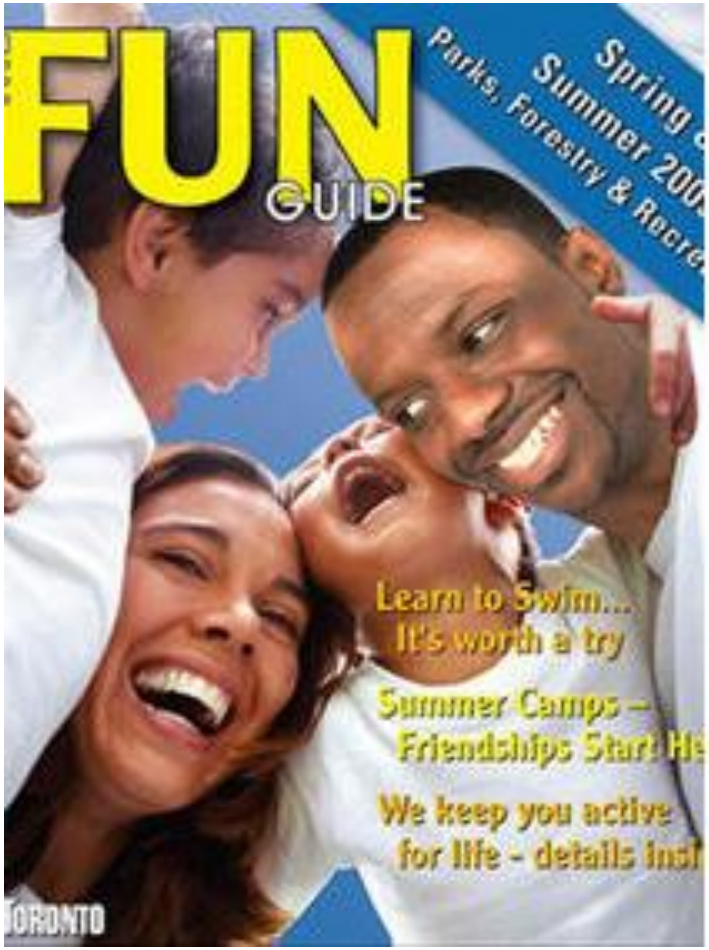
2007: Zhou Zhenglong claimed to take 71 photos of the nearly extinct South China tiger

Similar scandal in 2011 from Terje Helleso who won Swedish Env. Prot. award

(2012) A Russian newspaper distributed by a pro-Kremlin group printed a photograph showing blogger/activist Aleksei Navalny standing beside Boris A. Berezovsky, an exiled financier being sought by Russian police.



2008



2009: Digital diversity

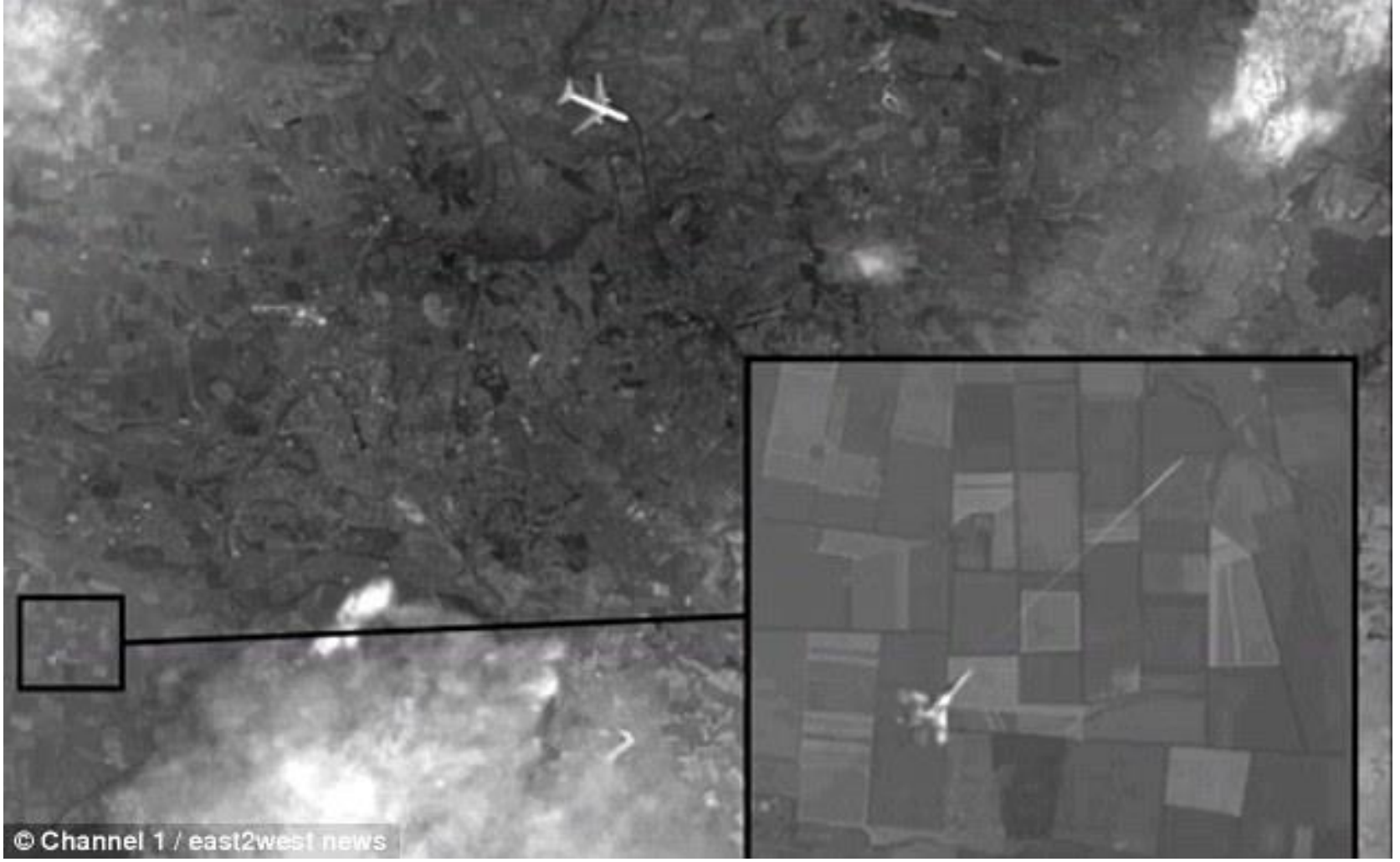
“Evidence” that Malaysian politician Jeffrey Wong Su En was knighted by the Queen (2010)

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

2013: fake floors, counter, appliances digitally added for listing in Luis Ortiz's show "Million Dollar Listing New York"

A farmer from Hunan province, China was sentenced to 12 years in prison and fined 500,000 yuan after receiving 453,00 yuan (US$73,000) in blackmail payments out of an attempted 9.47 million yuan. He had mailed to more than 200 officials pornographic photos into which he had inserted them using photo editing software. He threatened to publicize the photos unless he was paid. One of the victims claimed that he made the demanded payment before he “sensed later on that the man inside the photo was actually not me.”



Nov 2014: Russian state media ran a story with “proof” that a Ukranian jet shot down the Malaysian airlines plane. Photo is composed of Google Earth imagery, Yandex maps, and a stock photo of a Boeing jet.

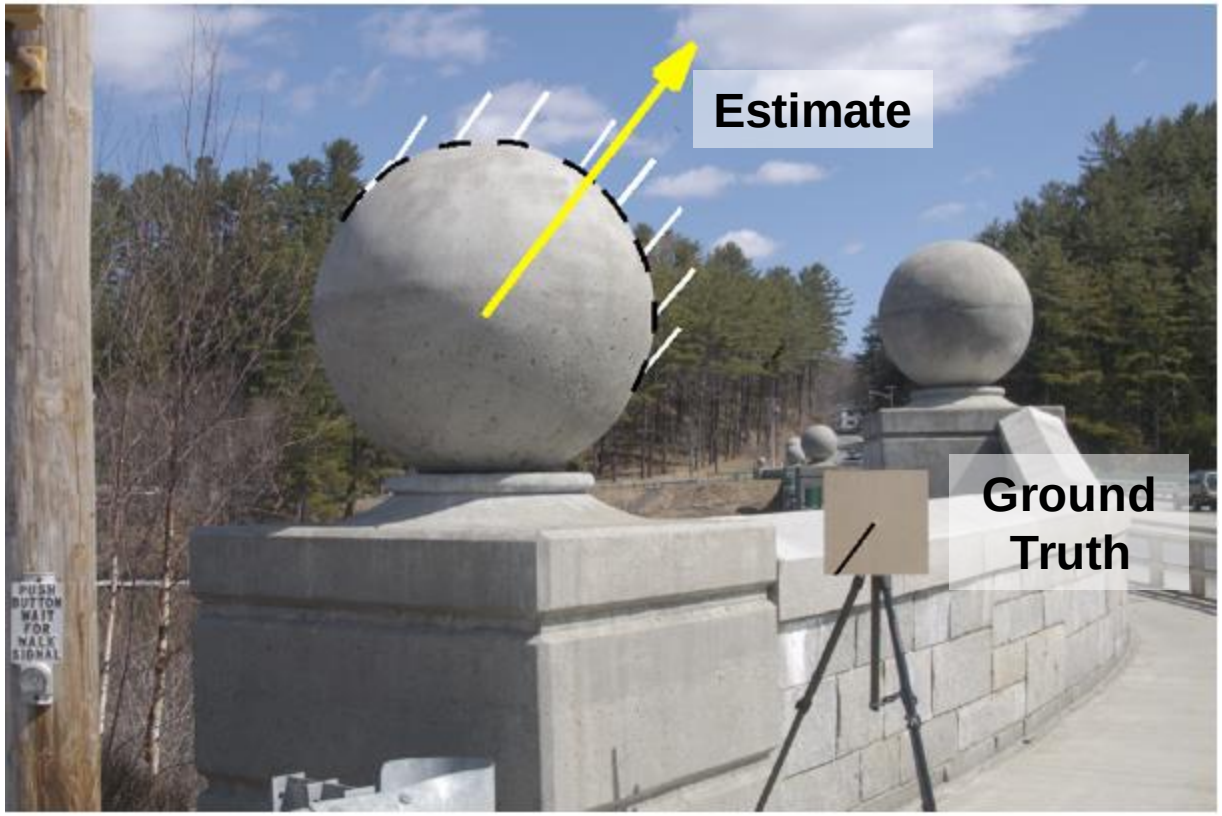
Detecting forgeries

- 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

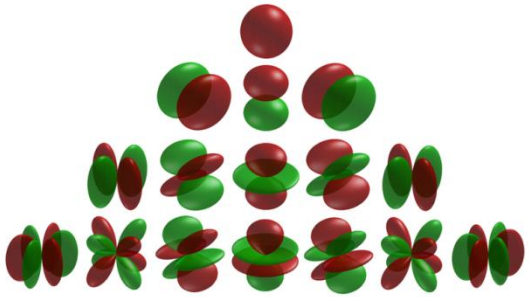
Method 2: Light from Eyes

Farid – “Seeing is not believing”, IEEE Spectrum 2009

Estimating Lighting from Eyes

Method 3: Complex light with spherical harmonics

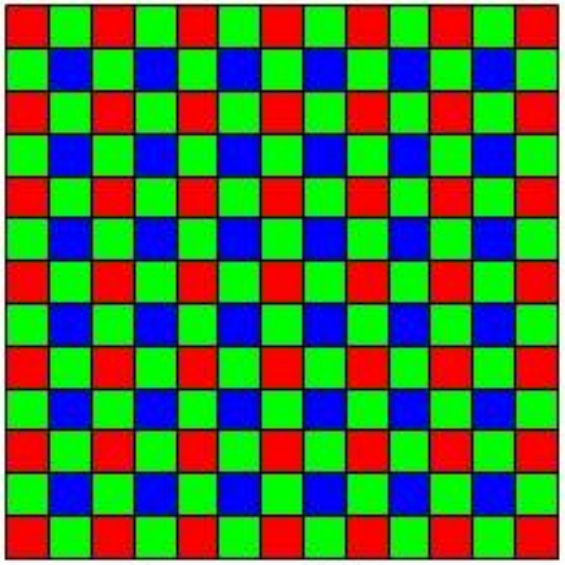
- Spherical harmonics parameterize complex lighting environment
- Same method as occluding contours, but need 9 points



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



Bayer filter

Farid: “Photo Fakery and Forensics” 2009

Demosaicking prediction

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

Error in pixel prediction from a linear interpolation

FFT of error in each window (periodic for untampered case)

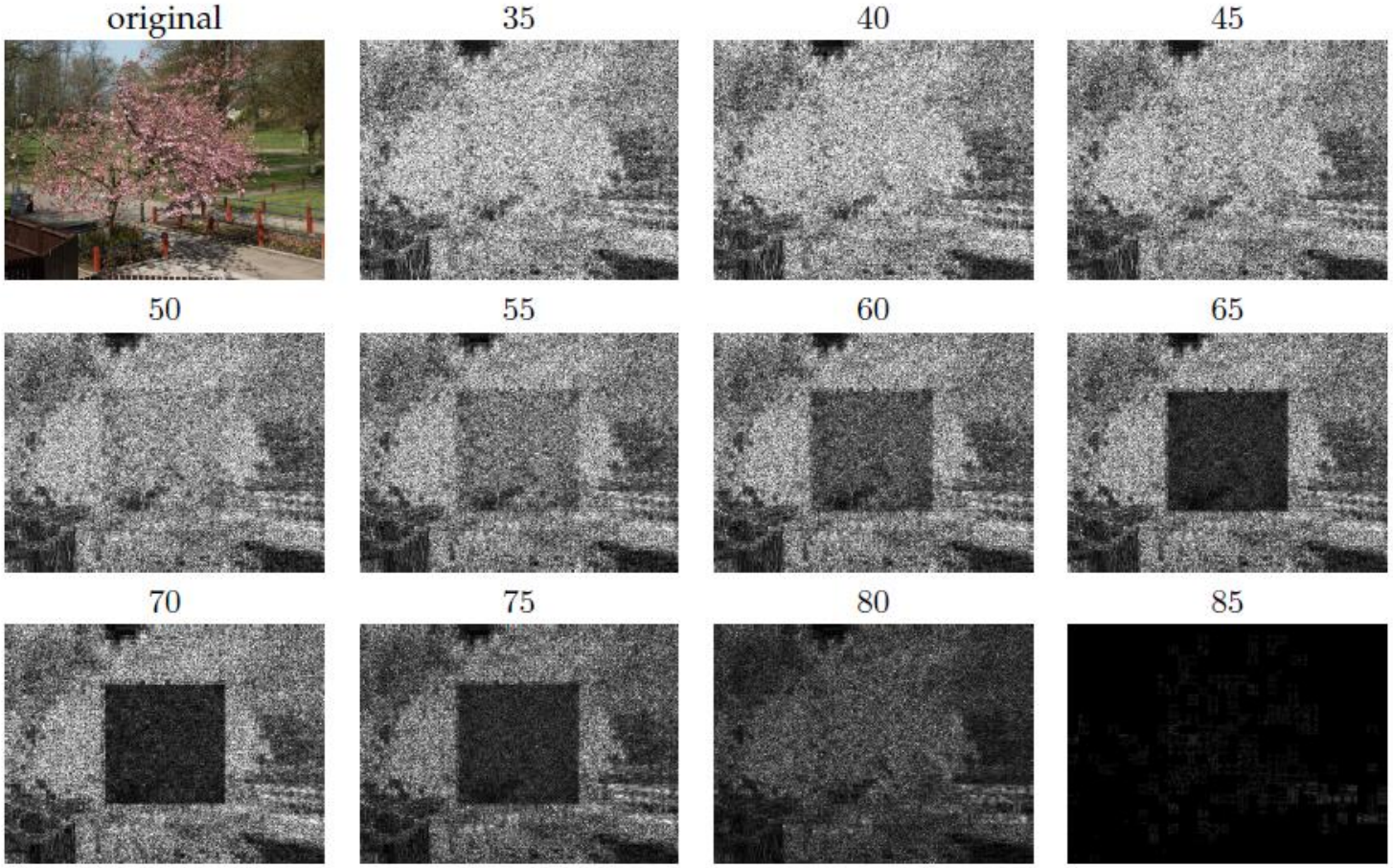
Method 5: JPEG Ghosts

- 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

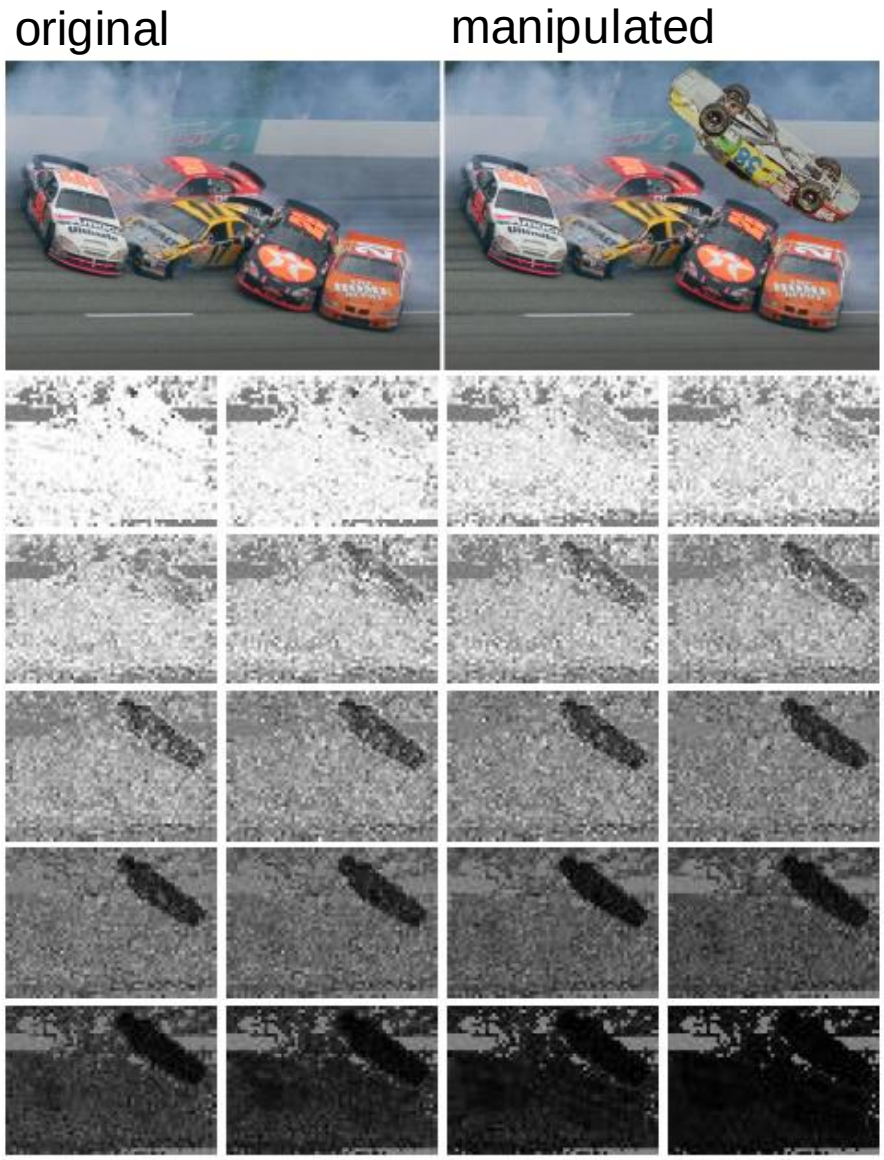
JPEG Ghosts

- 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

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

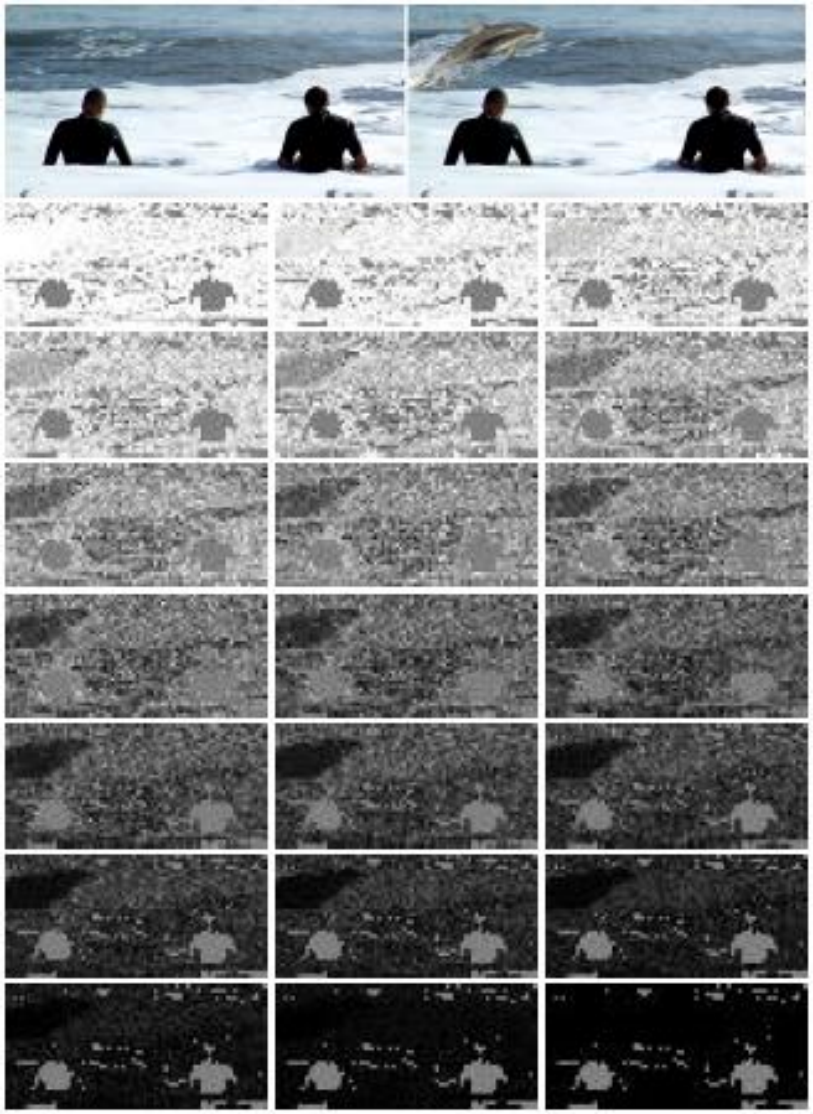
JPEG Ghosts



Pixel error for manipulated image saved at various JPEG qualities

JPEG Ghosts

original manipulated



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)

Upcoming

- Thursday: Computational approaches to cameras