An Online System for Classifying Computer Graphics Images from Natural Photographs

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dvmm DIGITAL VIDEO • MULTIMEDIA LAB

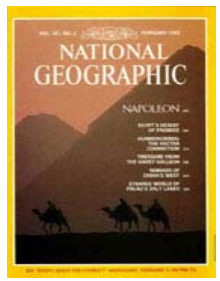
Background
Passive-blind Image Forensics

- Finding out the condition of an image without any prior information.
- Two main functions:
  - Image Forgery Detection
    - [Ng et al. 04] Photomontage Detection.
  - Image Source Identification
    - Photo vs. CG

Image Forgery Hall of Fame

LA Times ‘03

Internet ‘04



Nat. Geo. ‘92

Times ‘96

CG Or Photo?

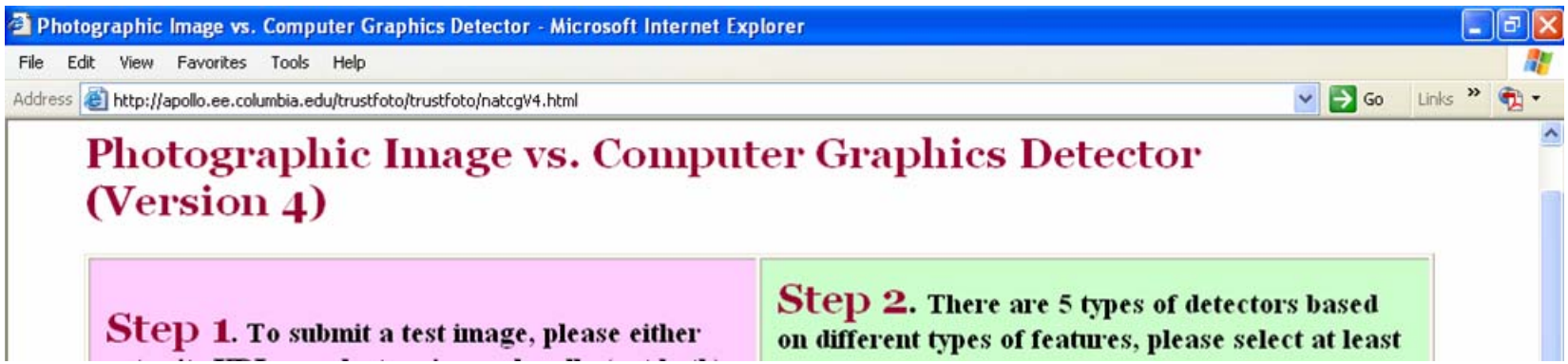
http://www.fakeorfoto.com
By Alias (CG company)

Prior Work
Photo vs. CG

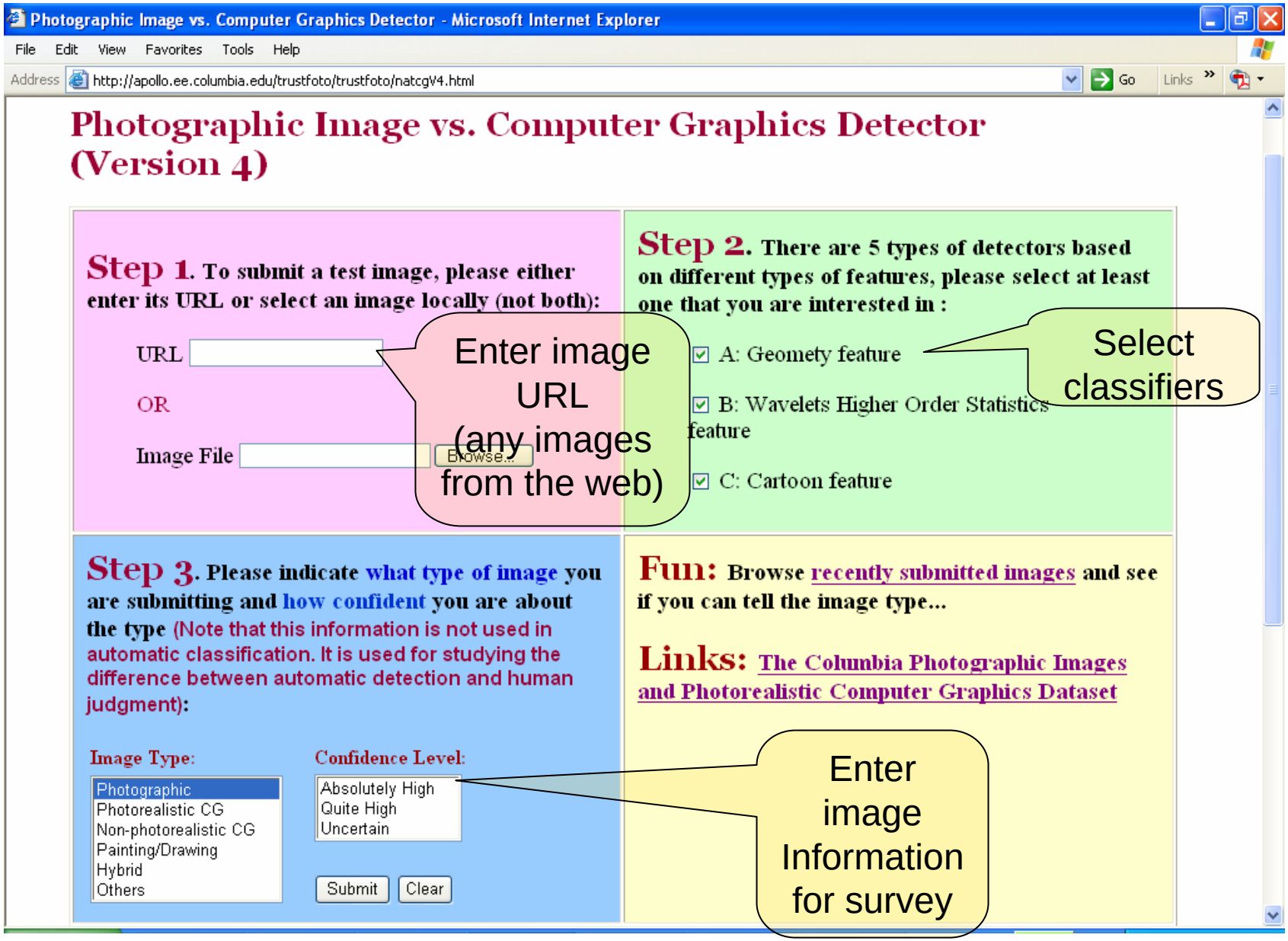
- [Ianeva et al. 03] Classifying photo and general CG (including drawing and cartoon).
  - For the purpose of improving video key-frame retrieval.
- [Lyu & Farid 05] Classifying photo and photorealistic CG.
  - Using wavelet statistics.
  - 67% detection rate (1% false alarm).
  - provides little insight into the physical differences between photo and CG.
- [Ng et al. 05] Analyzing the differences in the image generative process for Photo and CG.
  - Capture the differences with features derived from fractal geometry, differential geometry and local patch statistics.
  - The geometry classifier outperforms the methods in prior work.

Objectives for the Online System

- Further evaluate our technique in an open and realistic environment – the Internet.
- To compare the various proposed techniques for classifying Photo and CG.
  - The geometry, wavelet and cartoon classifiers.
- As an educational tool for promoting the awareness on the credibility of the online images.

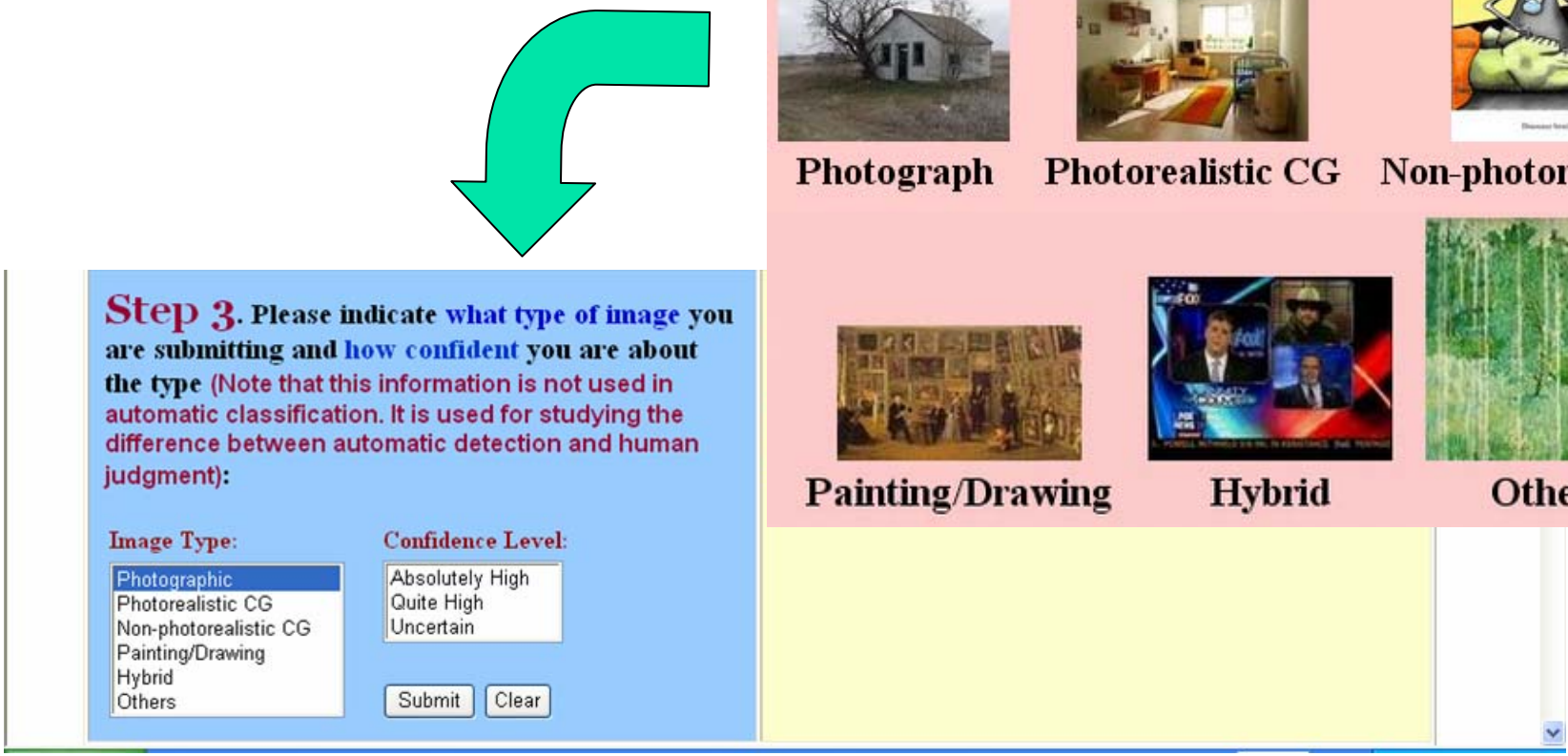


The Online CG-Photo Classification System



URL: http://www.ee.columbia.edu/trustfoto/demo-photovscg.htm

Online Interface
Image Types for Survey



The Results Page

Natural Images vs. Computer Graphics Detection Results - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://apollo.ee.columbia.edu/trustfoto/trustfotoV4/process.cgi

Go Links

Photographic Image vs. Computer Graphics Detection Results

Format = JPEG
Geometry = 586 x 419
Colorspace = RGB
Type = TrueColor
Depth = 8

Image Information

Detection Results

Geometry Feature	Computation time = **4.88** seconds Detection Results = **Computer Graphics** It has **0.01** chance to be a photograph
Wavelet Feature	Computation time = **1.71** seconds Detection Results = **Computer Graphics** It has **0.17** chance to be a photograph
Cartoon Feature	Computation time = **0.62** seconds Detection Results = **Computer Graphics** It has **0.01** chance to be a photograph
Wavelet+Geometry+Cartoon Fusion	Computation time = **0.14** seconds Detection Results = **Computer Graphics** It has **0.08** chance to be a photograph

Classifier Combined by SVM fusion (described later)

Return to the test page

This page is based on a perl-script from PerlScriptsJavaScripts.com

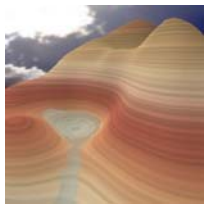
Sample Results

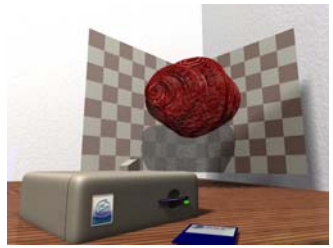
Key: match ✓ mismatch ✗

Consistency with Human Judgments

Human Judgments

CG




Photo





Statistics for online system

Total Submitted (since Oct 05)	Agree	Disagree
96	68%	32%

Note: Users sometimes provide wrong image types.

System Design Challenges

- The diverse input images from the Internet.
  - Not only just photorealistic CG, but also non-photorealistic CG, photo-CG-hybrid, painting or drawing and so on.
  - Solution: We include a class of non-photorealistic CG in our training data.
- Reasonable per-image processing speed.
  - Should not be more than a few minutes.
  - Solution: We reduce the processed image size.
- Classification accuracy.
  - Reduction of image size results in the loss of image details, hence, lower the classification accuracy.
  - Solution: We adopt classifier fusion which takes the training dataset diversity into account.

Dataset

Columbia Open Dataset

- First publicly available Photo/CG dataset.
- Consists of 4 subsets, 800 images for each subset.

From a few personal collections of photo

Personal Photo

Google Photo

Internet CG

Recaptured CG

Downloaded from Google Image Search

Downloaded from the 3D artist websites

Recaptured from a LCD screen by a Canon G3 camera

Available at http://www.ee.columbia.edu/trustfoto

Challenge I: Diverse Input Images
Non-photorealistic CG for Training

- For the online classifiers to handle CG other photorealistic CG, we includes a category of 800 non-photorealistic CG for classifier training.


Personal Photo


Google Photo


Internet CG


Recaptured CG



Non-photorealistic CG

Mainly for recapturing attack evaluation

Downloaded from Google Image Search

Challenge II: Processing speed

Image Size Reduction

- To improve the processing speed, we reduce the size of the input images to 360 pixels on the longer side.
  - The speed improves by at least 2 times, as the typical size of Internet images is about 700x500 pixels.
- We experiment with 2 strategies:
  - Downsizing – resolution reduction.
  - Central cropping – keeping central portion of the image without resolution change.
- Conclusion
  - Both strategies lead to a performance degradation.
  - Downsizing has a more uniform degradation over the 3 classifiers.

Classifier	Original size	Downsizing	Central Cropping
Geometry	83.8%	78.2%	79.9%
Wavelets	81.2%	77.3%	72.8%
Cartoon	76.1%	73.1%	75.9%

Sharp degradation: Global information matters.

Challenge III: Classification Accuracy

Classification Fusion

- To improve the classification accuracy, we produce a family of base classifiers by exploiting the heterogeneity of the training dataset for classifier fusion.

Diverse content type & from a few professional cameras.

Personal Photo

Google Photo

Internet CG

Non-photorealistic CG

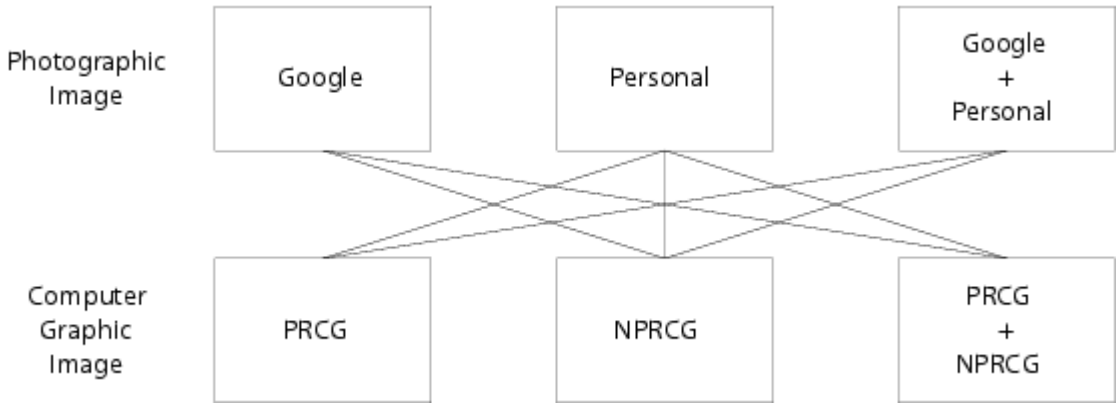
Diverse type of post-processing and camera.

Photorealistic

Non-photorealistic

Classification Fusion

- Generate 9 sets of two-class data by exhaustively combining the elements of the power set of the Photo and CG classes.
- Results for the fusion (geo+wav+car) classifier:
  - A gain of 2% in classification accuracy for the downsized images.
  - Close to the performance of the original image size classifier.



For geometry + wavelet + cartoon classifier

Original image	Downsized images
84.0%	82.0%

Conclusions

- We deploy an online Photo vs. CG online classification system.
  - **http://www.ee.columbia.edu/trustfoto/demo-photovscg.htm**
- We have described the strategies for addressing the implementation challenges:
  - Diverse input images – adding a class of 800 non-photorealistic images.
  - Processing speed – reducing the image size for processing.
  - Classification accuracy – exploiting the heterogeneity of the dataset and classifier fusion.