Real-Time Viola-Jones Face Detection in a Web Browser

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http://flashfacedetection.com

The Problem

- Finding the location and size of faces in an image
- Why it's hard?
  - Facial variations (expression, complexion, accessories etc.)
  - Pose (Rotation in and out of plane)
  - Occlusions
  - Clutter

Applications

- Face recognition
- Surveillance
- Motorized webcams (head tracking)
- Video games (Wii-style)
- Auto-focusing cameras

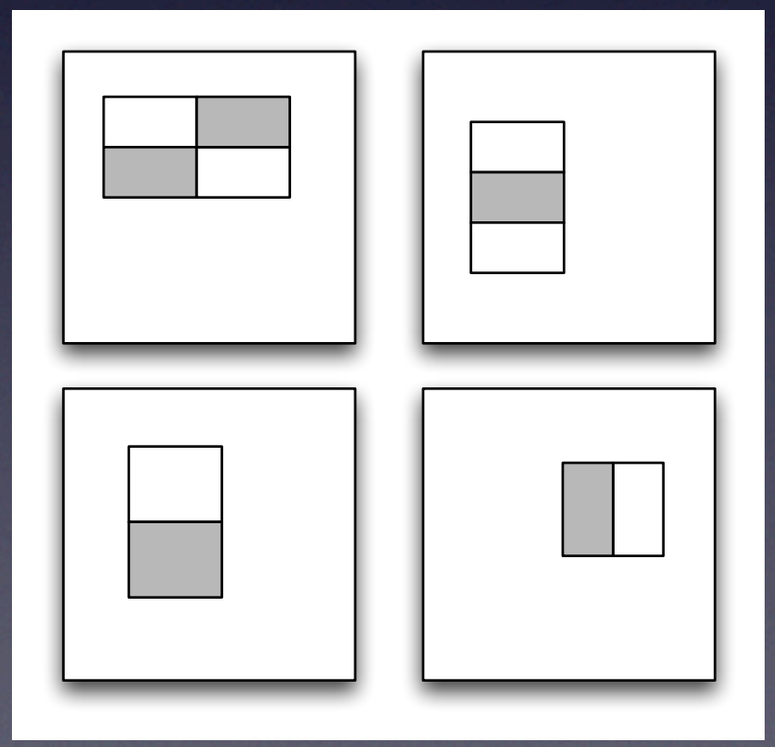
A Solution: Viola-Jones

- Paul Viola & Michael Jones - "Robust Real-Time Face Detection" (2003)
- Feature-based detector
- AdaBoost
- Robust and effective
- Implemented in OpenCV

Haar-Like Features

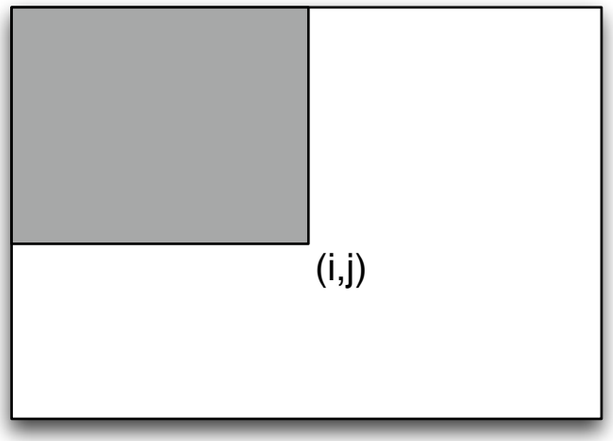
- Simple encoding of an image property
- Several variations
- Sum of light area minus sum of dark area

- Much faster than evaluating individual pixels
- Efficiently scalable
- Limited but extremely efficient

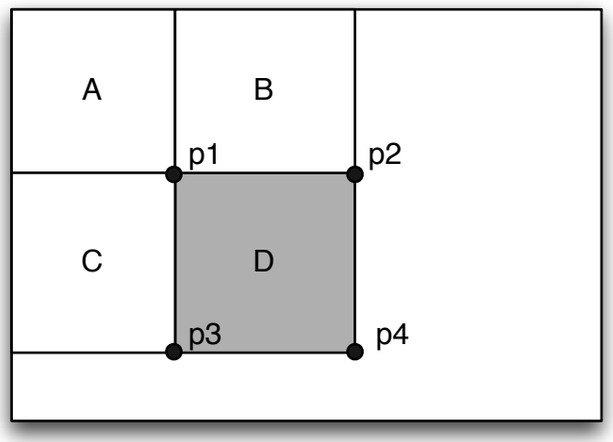


Integral Image

- Franklin Crow - "Summed-area tables for texture mapping" (1984)
- Very fast rectangle sum calculation (4 refs)
- 2-Rectangle features (6 refs)
- 3-Rectangle features (8 refs)
- 4-Rectangle features (9 refs)



ii(i,j) = sum of image intensities in shaded area



D = ii(p4) + ii(p1) - ii(p2) - ii(p3)

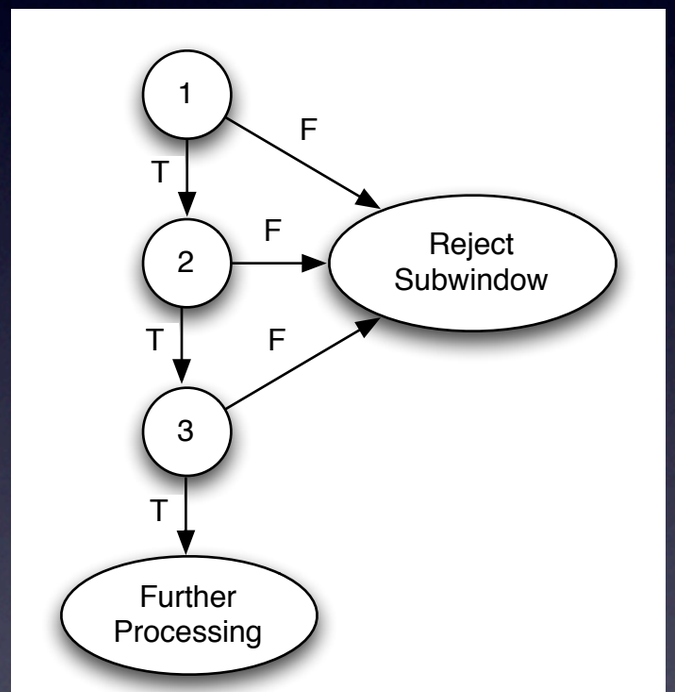
Choosing Features?

- 160 000 rectangle features in 24x24 sub-window
- Small subset can form an effective classifier
  - Combination of features and thresholds
- Machine learning techniques are used to select meaningful sets

AdaBoost: Adaptive Boosting

- Meta-algorithm - Freund & Schapire (1997)
- Combines weak classifiers in order to form stronger ones
- Repeatedly re-weights test set to boost data that caused errors (Adaptive Boost!)
- A set of strong classifiers can create an efficient face detector

Attentional Cascade



- Freund & Schapire - “Neural-network based face detection” (1997)
- Early stages discard as many negative regions as possible
- Later stages use complex classifiers to remove false-positives
- Stages are generated by adjusting AdaBoost to minimize false-positives or false-negatives

Algorithm!

- Run cascade on all sub-windows at a range of scales
- Sub-windows that pass the final level of the cascade are faces (hopefully)

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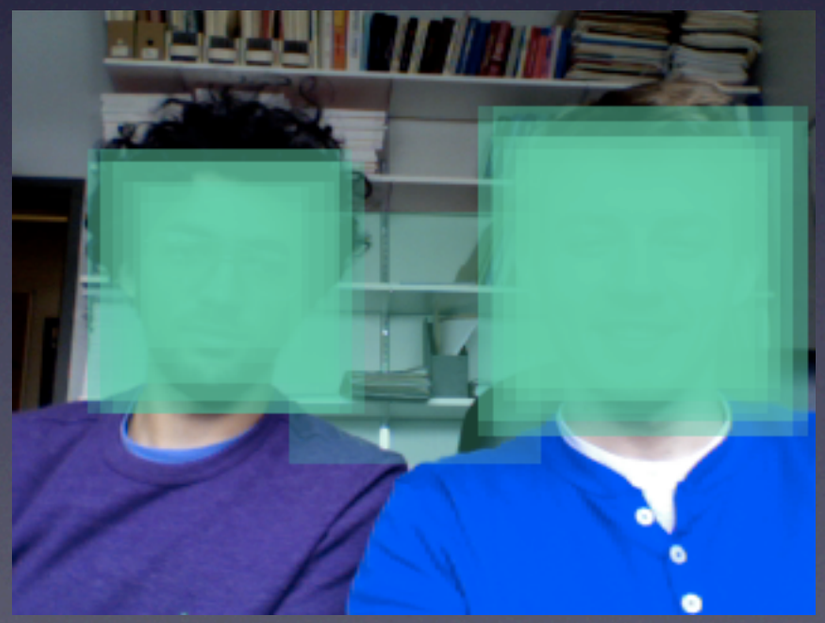
Detection Results



Why Flash?

- Multi-platform
- Webcam compatible
- No installation necessary
- Web-based distribution
- Large developer community
- No one has done it (without C++)
  - Slow, no direct memory access, etc

Assumptions

- Single face
  - Stop scanning after first detection
  - Largest face
- Face size & pose
  - Size bounds
  - Pose bounds
- Localizing the search
  - Use last detection to center search
  - Movement likely in image plane

Further Improvements

- Search within a small region around the first detection
  - Running only end of cascade
- Final detection will be average (location and size) of all detections within the region

Acknowlegdements

- Kaleem Siddiqi (McGill - CIM)
- Paul Viola & Michael Jones

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Demonstration!

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