Face Extraction From Live Video

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http://www.site.uottawa.ca/~afour005/honours_project/
One Problem With Face Detection
Solution: Keep Only One Image Per Individual

Easier said than done! But, that's what this project is all about...
Subproblems That Must Be Solved

- Detecting faces.
- Tracking moving objects.
- Associating faces to moving objects.
- Measuring the quality of face images.
Technologies Used

Before discussing the finer details of the project, let's consider some of the technologies upon which the project is founded:

Microsoft's DirectShow
- acquiring image sequences from files and camera devices

Background Segmentation Component
Contributed by Dr. Laganière
- labels pixel as background or foreground

OpenCv
- hundreds of image processing functions in C
- face detection via. cascading Haar classifiers
DirectShow Filter Graph
Background Segmentation
OpenCV Face Detection
Cascading Haar Classifiers

● “boosted classifiers working with haar-like features” [CV Reference Manual]

● Must be trained to recognize objects. (hundreds of positive examples, and hundreds of negative examples)

Keywords:
● Cascading – Regions of interest must be accepted by many simple classifiers.

● Boosted – The “simple” classifiers are actually composed of several basic classifiers. “Boosting” (weighted voting) techniques are then used to combine results.

● Haar-like features – the basic classifiers are decision trees that take “haar-like” features as input.
Haar-like Features

1. Edge features
   (a)  (b)  (c)  (d)

2. Line features
   (a)  (b)  (c)  (d)  (e)  (f)  (g)  (h)

3. Center-surround features
   (a)  (b)

[CV Reference Manual]
Measuring the Quality of Face Images

Let's assume that the OpenCV face detector works well (it really does!), that pedestrians can be tracked, and that faces can be associated to pedestrians.

Each frame of the input video can potentially add to the collection of face images for a single individual. We are only interested in the best of these images. How do we compare face images for quality?
Criteria Used to Judge Image Quality

Direction of Gaze – Images of people facing forward are desirable. (Determined, in part, by detecting face features).

Presence of Skin – Faces are mostly flesh.

Presence of Motion – People tend to move, even just slightly, from frame to frame.

Sharpness of Image – Images with motion blur are generally useless.

Quality of Lighting – Harsh lighting can confuse edge detectors. Good tonal range captures more details.

*Size of Image – Larger images are generally better, but may indicate a false positive.
Locating Face Features
Locating Face Features

Based partially on the paper “A Robust Algorithm for Eye Detection on Gray Intensity Face Images without Spectacles”, written by K.Peng, et al.
Detecting Skin in Color Images
Detecting Skin in Color Images

- Skin detection is one of the easiest ways to determine if a candidate region contains a human face.
- Many face detection systems use skin detection as a basic building block.
- This application uses skin detection only to score/rank face images, and to eliminate false positives.
Detecting Skin in Color Images

Research has shown that skin color, from all ethnicities, occupies only a small contiguous portion of the Hue/Saturation color space.
Measuring the Image Sharpness
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Given a sharp image and a blurry image of the same scene, the sharp image will have more high frequency content than the blurry image.

So, apply a highpass filter to the image!

High-frequency content: edges, lines, fine structures.

In faces, the high frequency content tends to concentrate around the face features (eyes, nose, mouth).
Measuring the Quality of the Lighting
Measuring the Quality of the Lighting

The quality of the lighting is measured using several histograms. These histograms represent the distribution of pixel intensities in a gray-scale image.

Wider histograms are better than narrow histograms. (The source images have the potential to store more information).

Faces are symmetrical across a central-vertical axis. If the lighting is soft and even, the distribution of gray values on either side of the axis should be similar.
Tracking Moving Objects

- The application uses a very simple tracker. First, it uses the background segmentation component to locate foreground pixels. It then identifies and tracks all of the connected components.

- The tracker remembers the maximum-connectedness of a component across many frames, thus forming groups.
Tracking Moving Objects

- The situation becomes complicated when there is more than one pedestrian in the scene.
- The software must be able to cope with merging and splitting events.
Tracking Moving Objects
Tracking Moving Objects

Merge
Tracking Moving Objects
Tracking Moving Objects

Split
Putting it All Together
The **Face Capture and Export Application**