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Assignment 4 301160793

Face Recognition Using Fourier Transforms

Method Description:

Each face image, identified by its subject and image # undergoes a Fourier transform. The most variant frequencies for the real and imaginary components of the Fourier transform are estimated using the Lower Quadrant method described in the paper. A feature vector containing these frequencies are constructed for each image so that comparison between each face image comes down to comparing the correlation (or diff factor) between the frequency vectors. The lowest diff factor corresponds to the best matching image for a test image in the sample set.

Several variations to the problem have been explored to investigate the recognition rate of the algorithm, such as:

* Padding the image prior to taking the fourier transform
* Rotating the image
* Adjusting the number of real & imaginary frequencies used in the feature vector
* Using different methods to compute the correlation factor (or diff factor)
  + METHOD:
    1. Diff = Euclidean distance of the real freqs
    2. Diff = Euclidean distance of the [real, image] freqs combined
    3. Diff = Sum of the Euclidean distances of the real/imag freqs separately

In test.m, I complied my various tests described above on 400 images tested against each other (400 images minus the test image) and compared the overall recognition rate:

Table 1 - Recognition rates for various methods

|  |  |  |  |
| --- | --- | --- | --- |
| Variation | Method to compute Diff | | |
| 1 | 2 | 3 |
| With image padding (Default) | 0.9400 | **0.9800** | 0.9800 |
| Without image padding | 0.9375 | 0.9650 | 0.9650 |
|  |  |  |  |
| Feature vector = <15 real, 12 imag> (Default) | 0.9400 | **0.9800** | 0.9800 |
| Feature vector = <22 real, 8 imag> | 0.9575 | 0.9750 | 0.9725 |
| Feature vector = < 5 real, 5 imag> | 0.7425 | 0.9450 | 0.9400 |
|  |  |  |  |
| Rotation by 10 degrees | 0.7650 | 0.9150 | 0.9050 |
| Rotation by 30 degrees | 0.1150 | 0.2075 | 0.2150 |
| Rotation by 90 degrees | 0.0700 | 0.0450 | 0.0500 |
| Rotation by 180 degrees | 0.9350 | 0.0700 | 0.2000 |

Methods not considered:

* Using the magnitude of the Fourier transform was not considered because the imaginary components of the frequency contribute less to the overall image, so taking equal amounts of real and imaginary components for the feature vector leads to waste in computation.
* Comparing the negative dot product of the [real, imag] freqs to determine the Diff coefficient was not considered since this was actually an incorrect way to measure the difference between 2 vectors. (ex. 2 vectors can be completely different but lie in the same direction. The dot product between these 2 vectors however will be very high, implying high correlation, when there is actually low correlation instead.

Results from test:

The method that lead to the highest recognition rate was padding the images first (replicating the image borders to fit in a 128x128 image), and comparing 15 real freqs and 12 imag freqs by measuring the diff as the Euclidean distance of the [real, imag] freqs combined. This lead to an overall recognition rate of 98%, the same rate that was achieved in the paper.

Other thoughts:

For the rotation cases, if the image was rotated slightly, it was still recognizable by the algorithm. However, a rotation of 30 degrees or more causes the recognition rate to drop rapidly below 21%. One strange thing is that for an image rotated 180 degrees, method 1 of calculating Diff (using real freq’s only) produces a 94% recognition rate. This perhaps might be because faces are usually symmetric and the real component of the Fourier transform of an image is less invariant to shifts in the general frequency pattern of the image.