Photorealistic x Photographic

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Paper Link - http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1381784

Overview

The main aim of the paper was to develop a method for differentiating between photographic and photorealistic images, or live and rebroadcast images, so that photographs can be used as a form of concrete evidence and proof.
To achieve this goal, the paper uses filters to divide the image into Horizontal, Vertical and Diagonal Subbands, in each of the three RGB colours.

Since in natural images, the value of a pixel depends heavily on the values of the neighbouring pixels, we set up a linear recurrence using these values and solved for the closest fit to this.

Having computed the basis coefficients and error terms, we input these to a Support Vector Machine, which does the task of classifying the images for us using supervised learning.

Filtering

The paper used Separable Quadrature Mirror Filters to divide the image into subbands. The low pass and high pass filters used were given in the paper.

The method of implementation of Quadrature Mirror Filters were given in the papers -

- P.P. Vaidyanathan. Quadrature mirror filter banks, M-band extensions and perfect reconstruction techniques. IEEE ASSP Magazine, pages 4–20, 1987.
- Link - E.P. Simoncelli and E.H. Adelson. Subband image coding, chapter Subband transforms, pages 143–192. Kluwer Academic, 1990.
- Link - M. Vetterli. A theory of multirate filter banks. IEEE Transactions on ASSP, 35(3):356–372, 1987.

Basically, a Quadrature Mirror Filter has coefficients that are symmetrical about $\Omega = \frac{\pi}{2}$. In addition to this, it also has the property that the power sum of the Fourier Transform of the low pass filter at a given frequency and the frequency + π is equal to 2.

A set of example QMF Filters and the method for designing them is given in the appendix of Paper 2 (E.P. Simoncelli et. al.), and it is the 9 tap QMF Filter that has been used in the original paper that we are trying to implement.

To implement this, we first tried to take the row wise and column wise convolution of the image with the fi2lters to get the HH, LH, and HL subbands. This did give us results similar to what we expected, but the point of the Quadrature Mirror Filter was also to compress the image to a fourth of its original size. In this case, the size of the image remained the same.

We then used the inbuilt imfilter function in Matlab, but the issue persisted.

So, we instead we thought of using the wavedec2 function in Matlab that performs 2D Wavelet Decomposition, and adding the Quadrature Mirror Filter to the wave manager in Matlab. However, the filter given had an odd number of terms while Matlab required the filter to have an even number of terms.

Finally, we decided to create a new QMF Filter altogether with an even number of terms so as to get the wavemanager to work. We found a matlab file for QMFDesign on the internet, and used it to make a QMF Filter with 16 terms which was finally accepted by Matlab as a valid wavelet filter.

Using the wavedec2 decomposition function, we were able to implement the multiscale subband decomposition as done in the paper.

We decomposed the image into a 4-level 3-orientation QMF Pyramid, by calling the wavedec2 function with scale level 3.

Calculation

As described in the paper, the basis coefficients ($\vec{w}$) were calculated using the least squares minimization method (pseudo-inverse) by forming the Q matrix as described in the question paper.

The log error term ($\vec{p}$) was calculated in a manner similar to the paper and the mean, variance, skewness and kurtosis of both vectors were calculated.

Training of SVM

Using these 8 statistics for each of the 3 subbands, for each of the 3 colours and for each of the 3 scales yields a total of 216 features using which we can train our SVM.

Unfortunately, the websites that were given in the paper were no longer functioning, and we could not download the test images from there, so we got the images from the websites -

- Photographic - https://www.ee.columbia.edu/ dvmmweb/dvmm/downloads/PIM_PRCG_dataset/dataset-download.htm
- Photorealistic - http://www.irtc.org/stills/

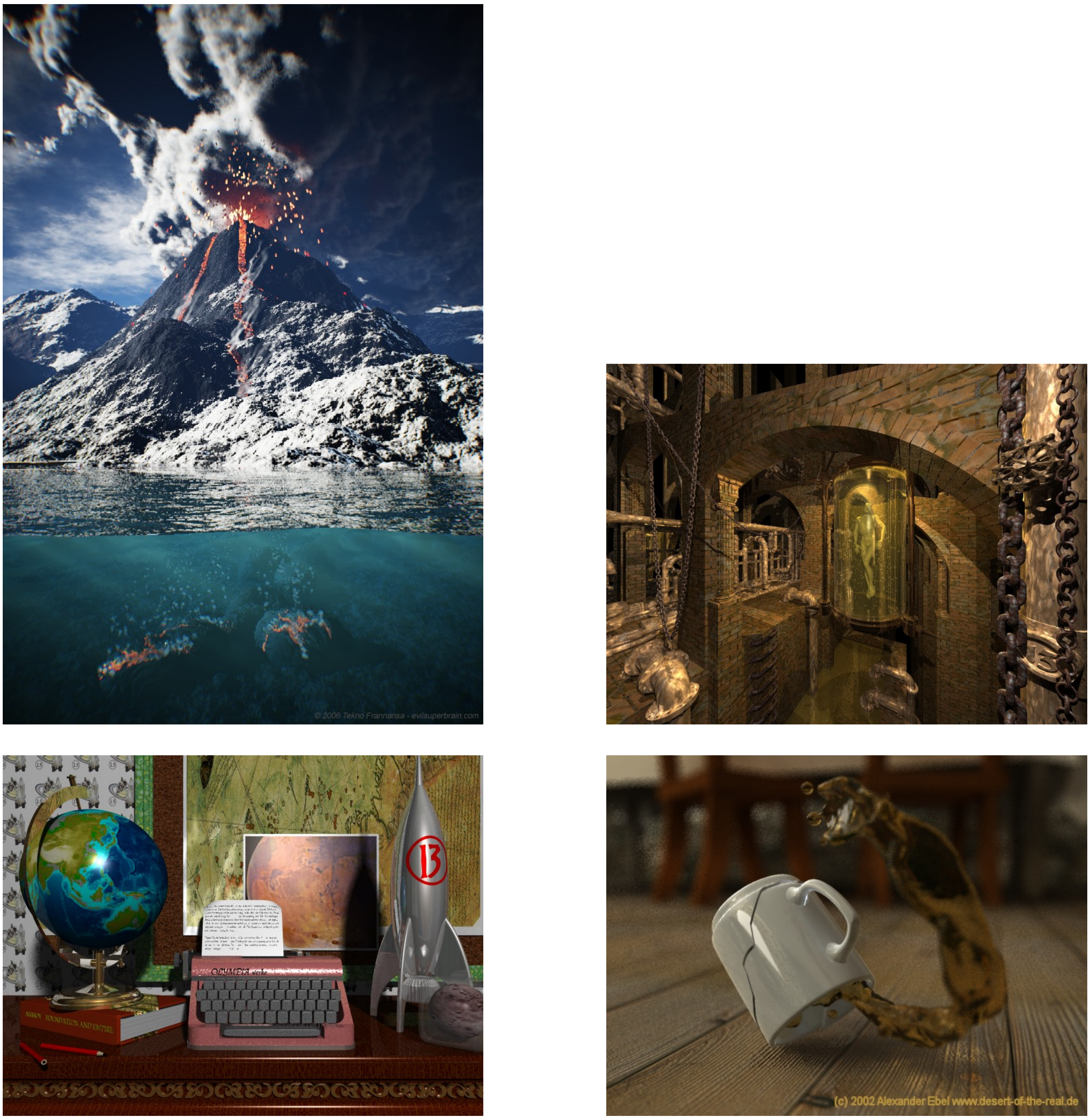
We used a training data set comprising of 700 photographic images and 861 photorealistic images, and a testing data set comprising of 100 photographic and 94 photorealistic images.

Results

- Photographic Image Accuracy - 84/100, 84.00%
- Photorealistic Image Accuracy - 76/94, 80.85%

We attribute the difference in the paper accuracy levels and our levels to the different data sets, size of the data sets and the different Quadrature Mirror Filter used.

Incorrectly Classified Photographic Images



Incorrectly Classified Photorealistic Images