Term Project For Image Processing

GROUP 6

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OVERVIEW

Texture segmentation is an important problem in image processing where an image is segmented into clusters based on regional statistics such as coarseness, colour, regularity, etc. Our problem is to cluster a mosaic of 16 textures using image processing techniques.

We first extract a set of 111 images from the Brodatz texture album at **http://www.ux.uis.no/~tranden/brodatz.html**. From the obtained set of stochastic texture images, we make a mosaic of 16 distinct textures in a 4x4 arrangement, without any spacing between them. We then devise and implement an algorithm, based on suitable feature extraction, to segment the 16 different textures in the mosaic.

LIBRARIES/FRAMEWORKS USED

The implementation is based on *Python 2.7*. We also used

1. OpenCV-Python
2. SciPy
3. NumPy
4. Scikit-learn
5. argparse, glob

APPLICATION DESIGN

1. Texture Procurement and Mosaic Generation

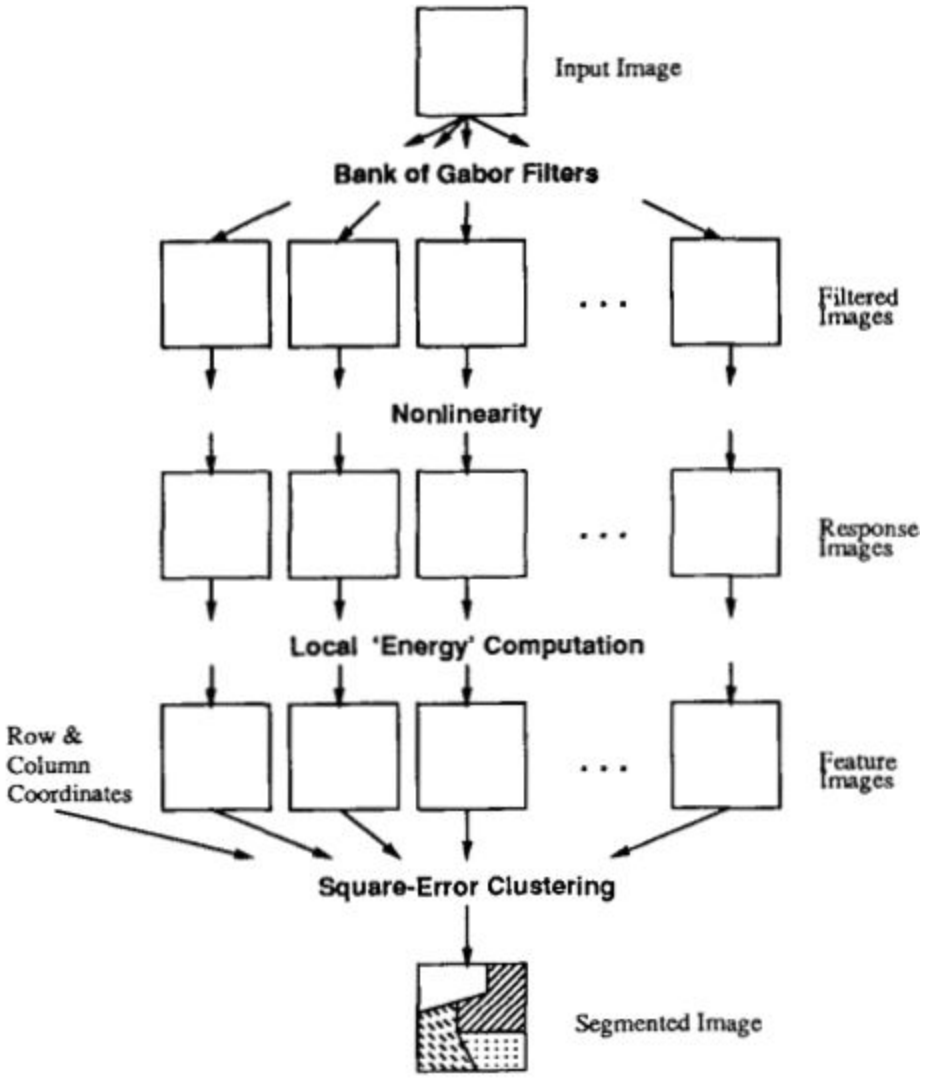
- The first step involved procurement of the texture images from the Brodatz texture database and converting them to a processable form.
- A set of 16 distinct, random textures are selected from the set of images, and a 4x4 mosaic is generated.

2. Unsupervised Texture Segmentation using Gabor Filters

- Blob detection is done using a nonlinear transducer, to get a series of response images. The size of the window used for transduction is determined with respect to the radial frequency that the Gabor filter in the previous step is tuned to.
- A local energy computation is applied to the smoothed response of the activation function.
- Feature images are combined and a clustering scene is applied to present a segmented image.

3. Getting Gabor Filters and Producing Filtered Images

- Gabor Filters are orientation-sensitive filters, generally used in texture analysis. For a given direction, the corresponding Gabor filter set returns a strong response for locations of the target images with structures in the given direction. They are a special class of bandpass filters.
- When Gabor filters are applied to an image, the strongest response is obtained at edges. This is can be extended to changes in textures as well.
- Parameter values have been taken from the paper: Ψ has been varied as 0, $\pi/4$, $\pi/2$ and $3\pi/4$ and λ has been varied from $4\sqrt{2}$ to width$\sqrt{2}/4$ in multiples of 2.
- The filtered images were obtained by applying the obtained filters on the images.



4. Applying Nonlinear Transduction and Gaussian Smoothing

- Once we get the filtered images, we drop some of them to reduce the error in reconstruction of the image. We use an error function that utilizes the difference of using all the filters and using a single filter. The algorithm is as follows:

    i. Find the filtered image with smallest error.

    ii. Look for images which, when added to the current image, approximate the new image better.

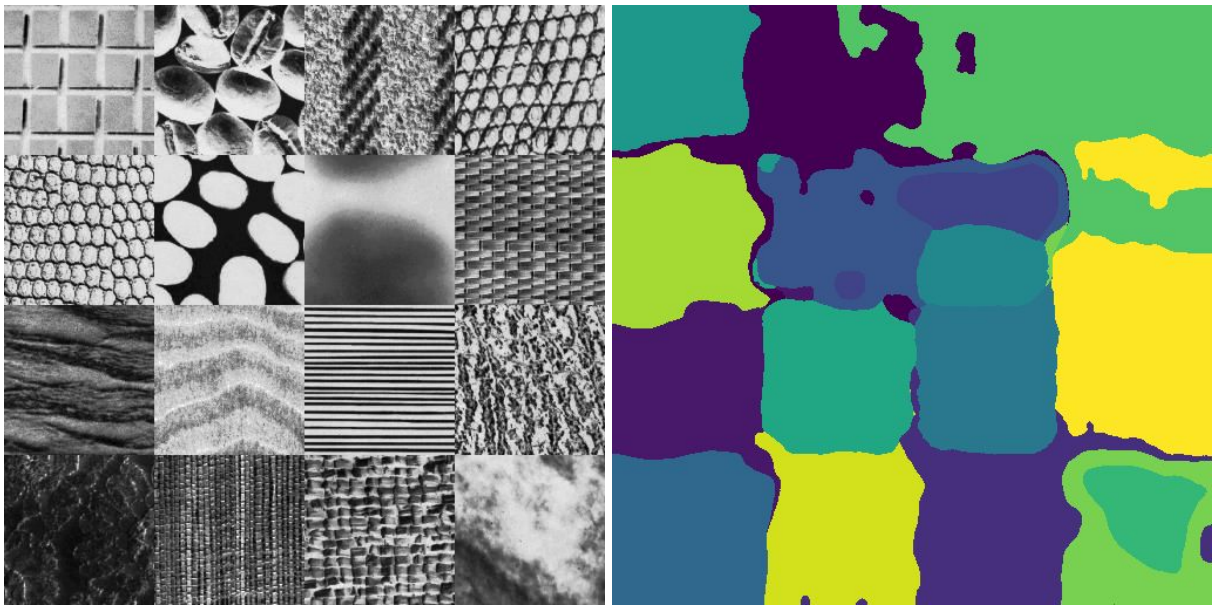
    iii. Repeat ii. until the error becomes < 5%.

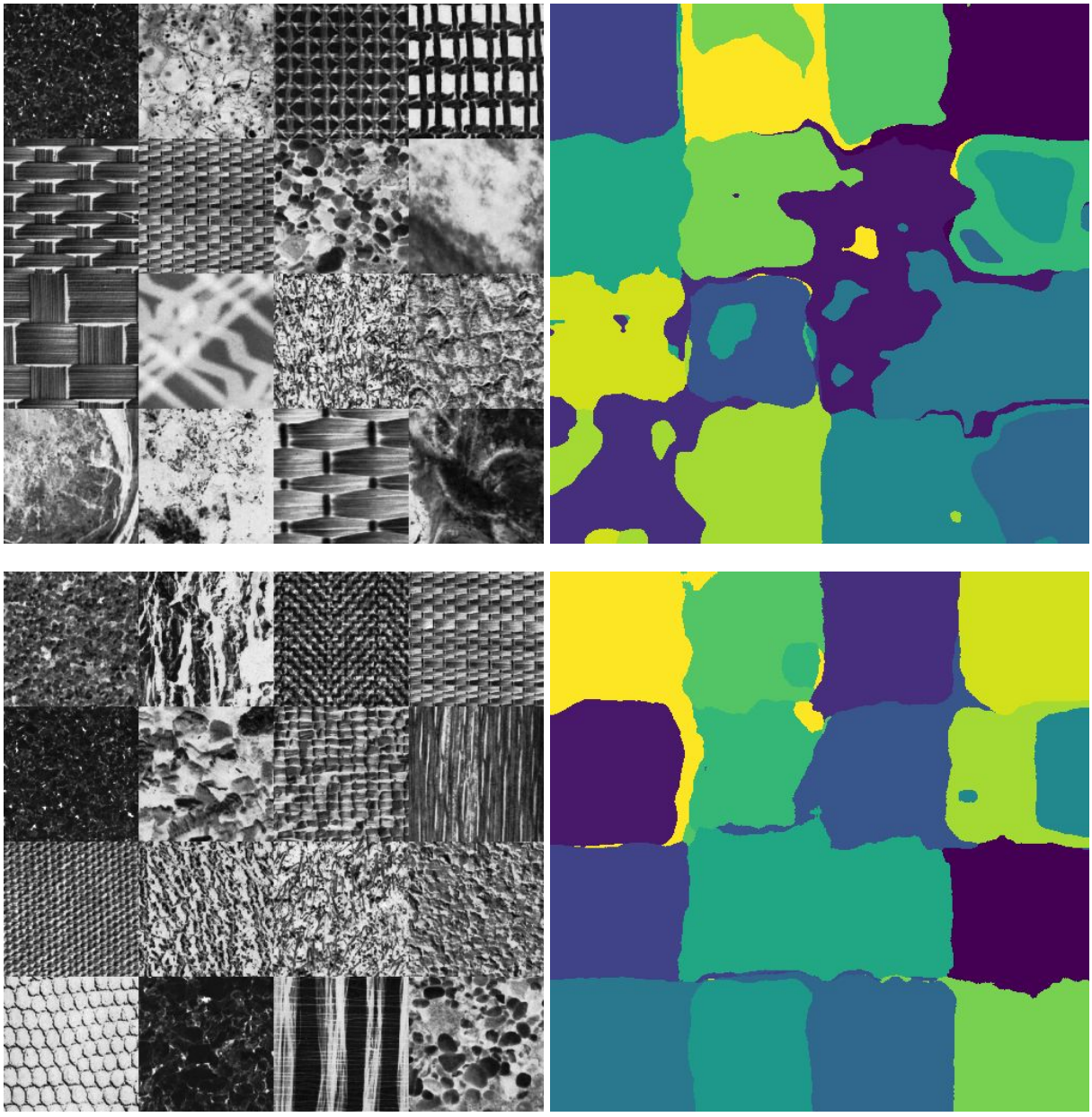
- A *tanh* activation function is used with an activation window. For the filtered inputs, features are exaggerated once the transducer is applied, as it is nonlinear. Due to the thresholding nature of the sigmoidal function, the more prominent qualities are thresholded and gain importance. Thus, it is called an activation function. Weights of features are associated directly with their prominence, helping clustering of features.
- Gaussian filters are now used to smooth each filtered image.

5. Final Clustering

- Once all the feature images are obtained, the features are obtained such that the value of each pixel in a single feature image counts as a feature for its coordinates. Thus we can construct a feature vector, for each set of coordinates, of size equal to the number of feature images.
- As we know the number of textures in the image (16), we can apply K-Means Clustering on the obtained feature vector set to obtain the final segmented image.

RESULTS





REFERENCES

[1] A.K. Jain, F. Farrokhnia, “Unsupervised texture segmentation using Gabor filters”, 1990 IEEE International Conference on Systems, Man, and Cybernetics Conference Proceedings.