

Texture Classification and Representation using 2D Textons

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The Algorithm

- Classification

Training

- Input: One texture image ($m \times n$) per texture class, q texture classes, a filter bank having p filters.
- Output: Histogram Database
- Algorithm:
 - For an image, for each pixel, convolute filters from filter bank to get a vector of size p .
 - Apply k-means algorithm on all $m \times n$ vectors, to get k vectors each of size p . These are called textons, which are particular to an image.
 - Generate k textons in the same way for all the texture classes. Thus, we get a texton database of qk textons.
 - Now, consider an image of a texture class. We have a p -length vector for each pixel in this image. Find the closest texton to this vector in the texton database using euclidean distance. Create a histogram of this mapping with the textons in the texton library on the x-axis.
 - Thus, we get a database of q histograms which we will use for classification.

Testing

- Input: An image, texton database, histogram database, filter bank
- Output: The texture class to which the image belongs
- Algorithm:
 - For each pixel, apply filters from filter bank to get a vector of size p .
 - Find the closest texton to this vector in the texton database using euclidean distance. Create a histogram of this mapping with the textons in the texton library on the x-axis.
 - Find a histogram closest to test histogram from histogram database using chi-square distance. The image belongs to this texture class.

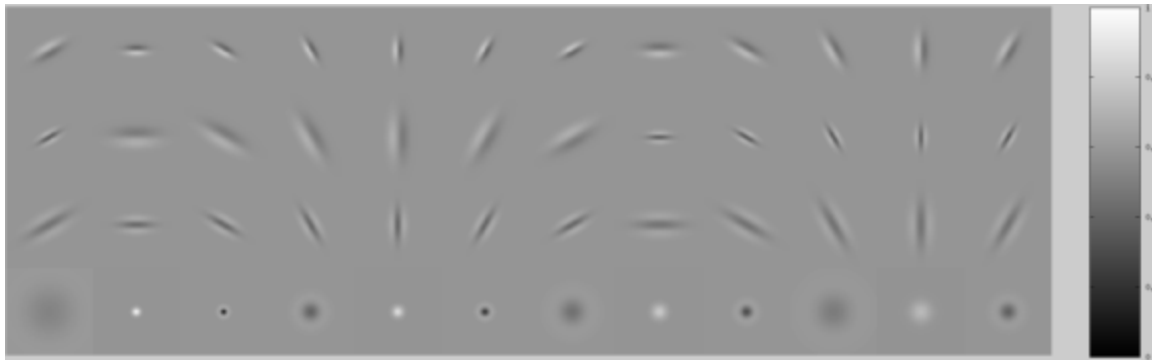
- Texture Reconstruction

- Input: Textons generated for a texture image, mapping of each pixel to a texton, filter bank
- Output: Reconstructed texture image
- Algorithm:
 - Pseudo-inverse of filters from filter bank is applied on each texton to get a patch associated with that texton.
 - For each pixel, get the mapped texton (Using the mapping we get from K-Means). Assign the intensity of the center pixel in the patch associated to the texton at that pixel.

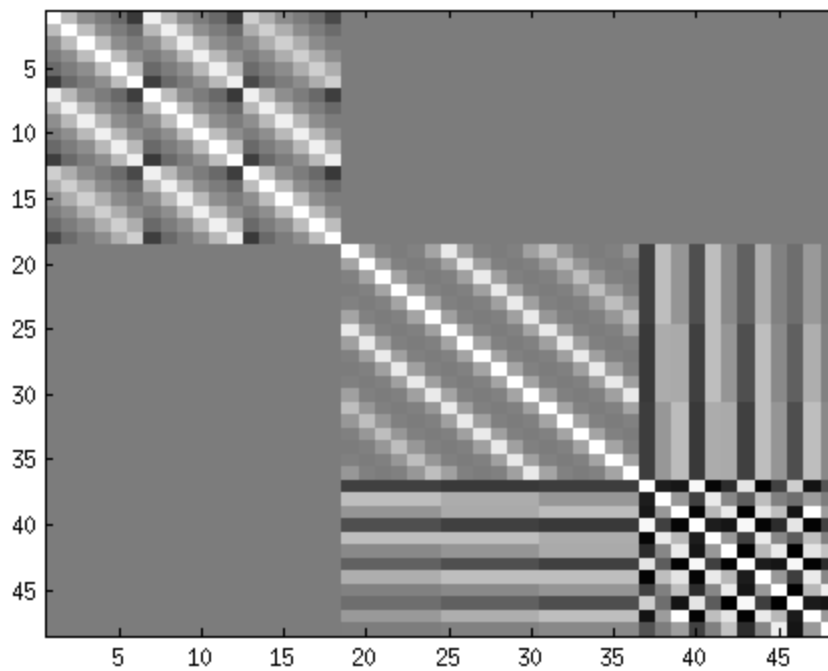
Results

- Visualization of the three filter banks

LM Filter Bank

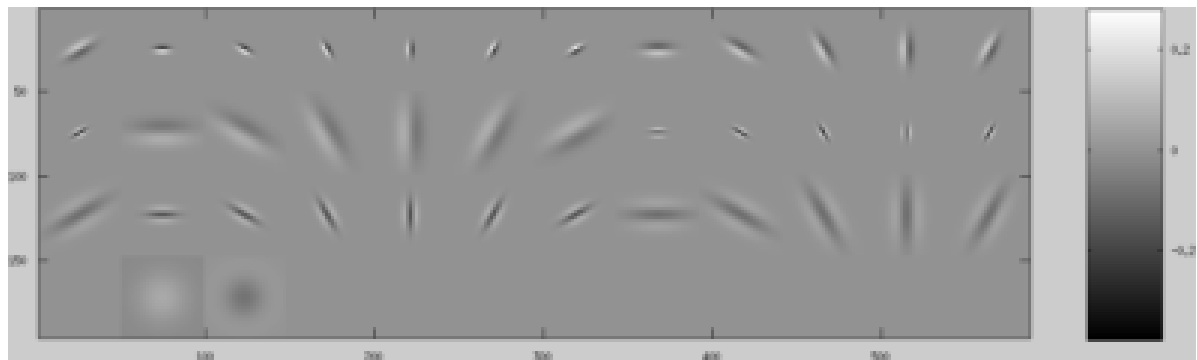


Filter Visualization

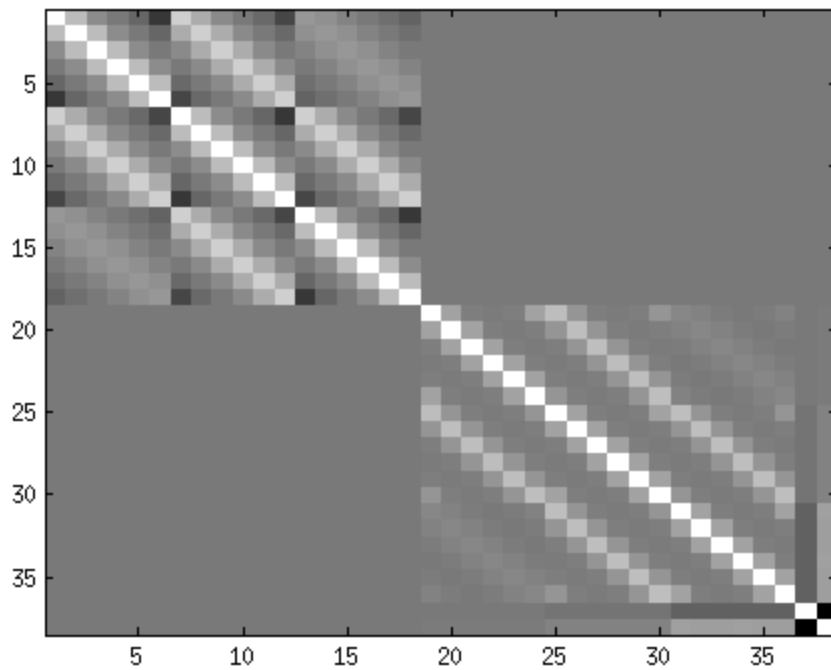


Filter Correlation Matrix

RFS Filters (MR8 is derived from RFS)

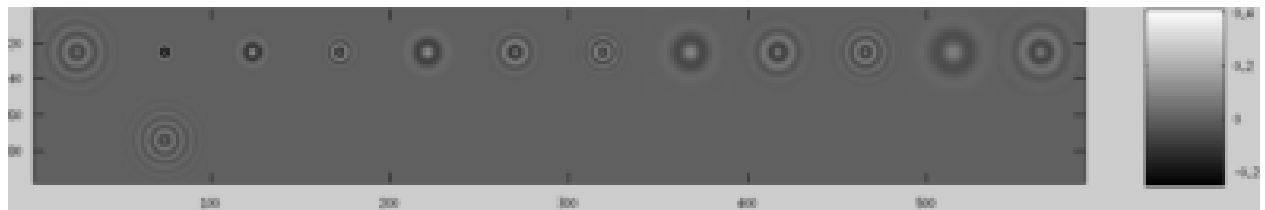


RFS Filter Bank Visualization

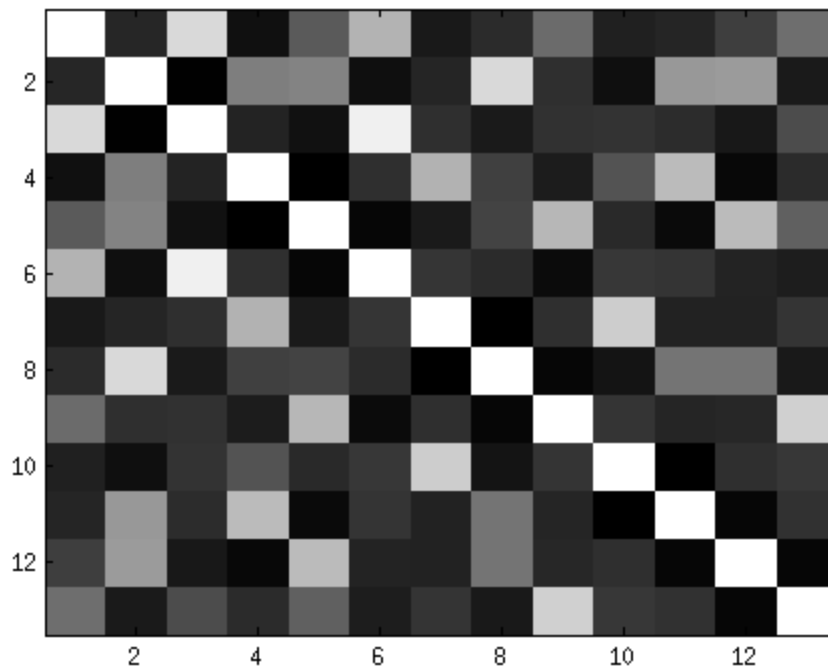


RFS Filter Correlation Matrix

S Filter

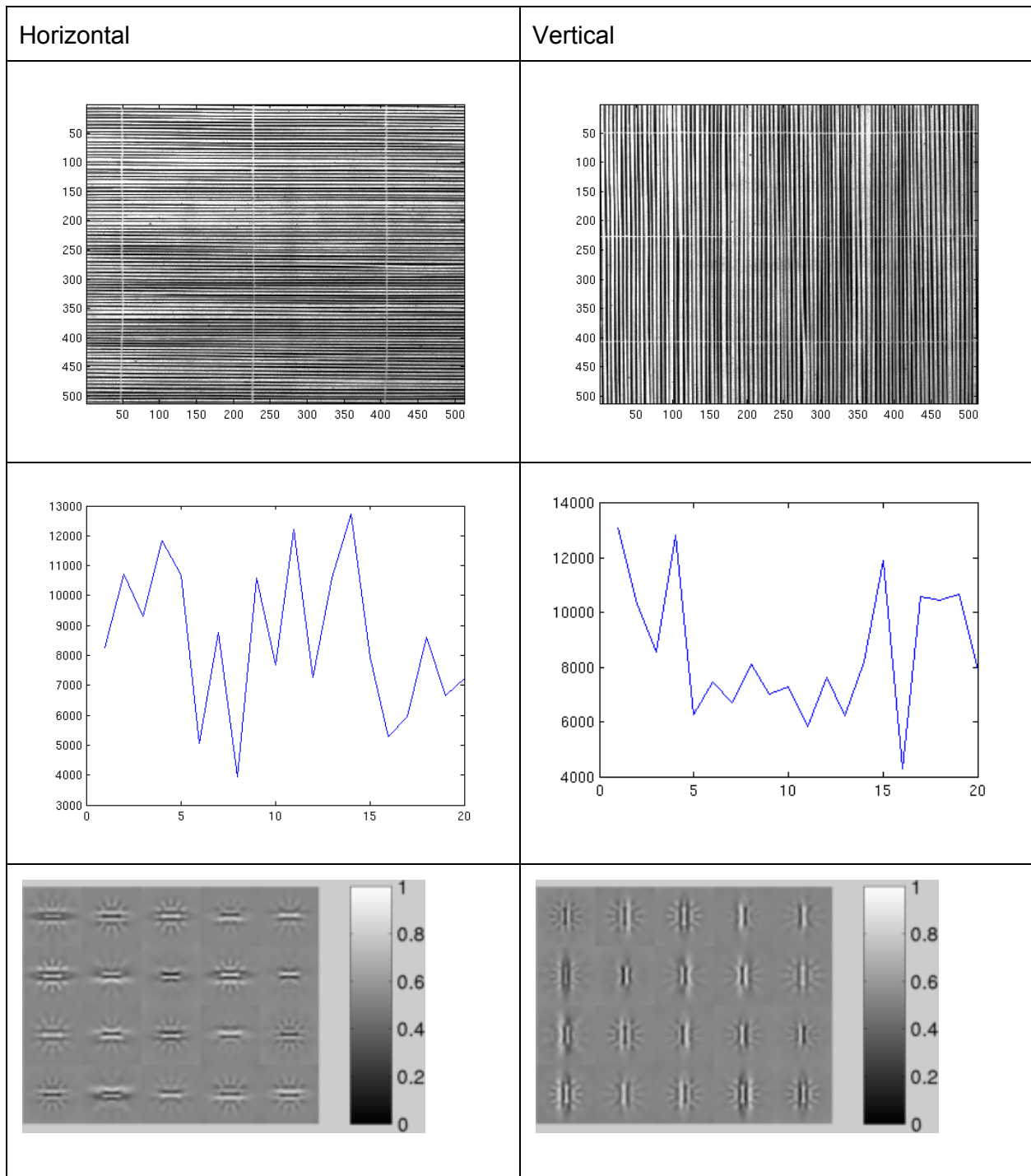


S Filter Visualization

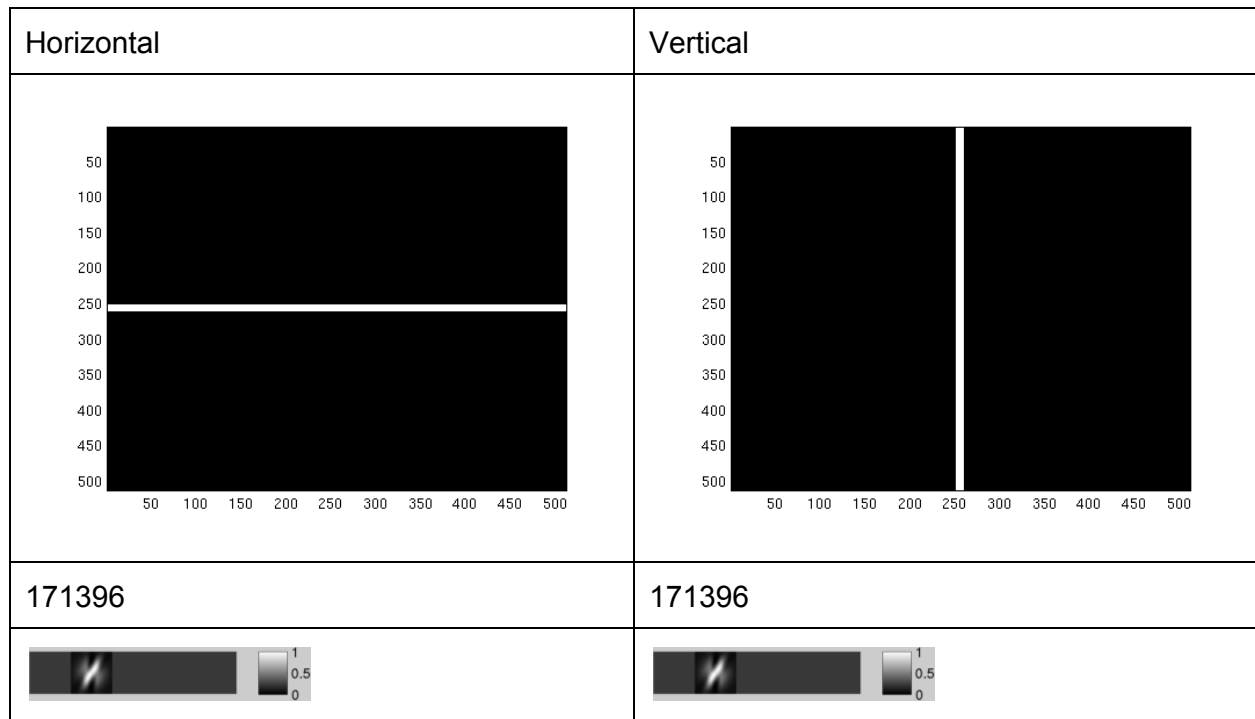


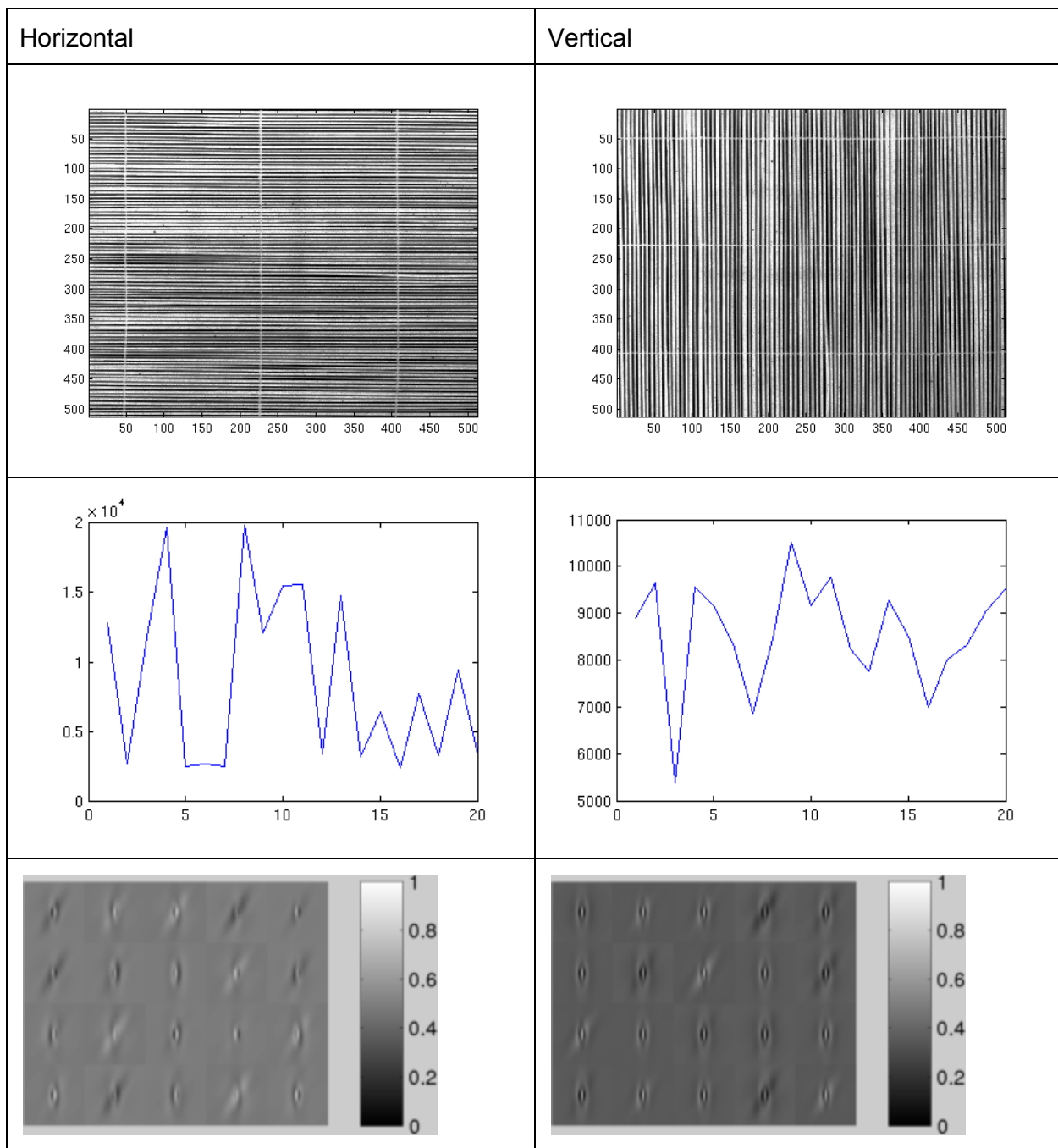
Correlation Matrix S Filter

- Rotational Variance of LM filters

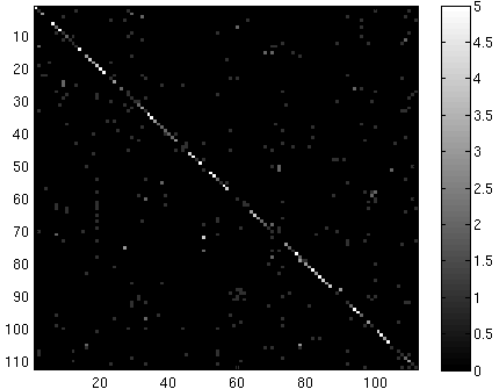
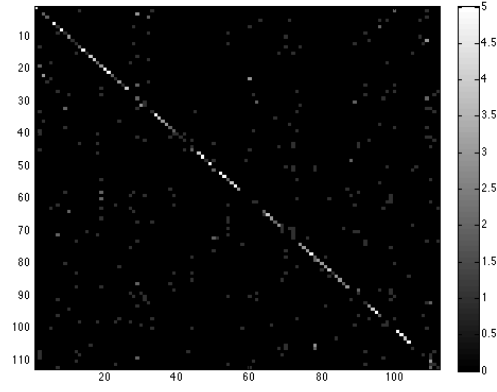
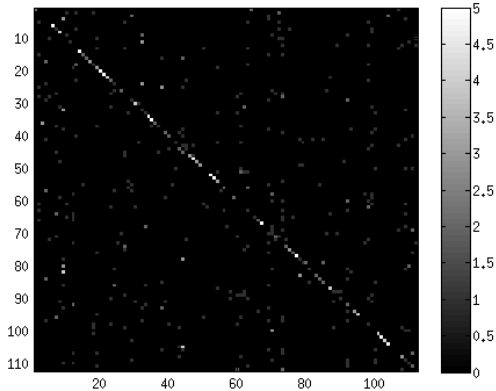


- Rotational Invariance of MR8 filters

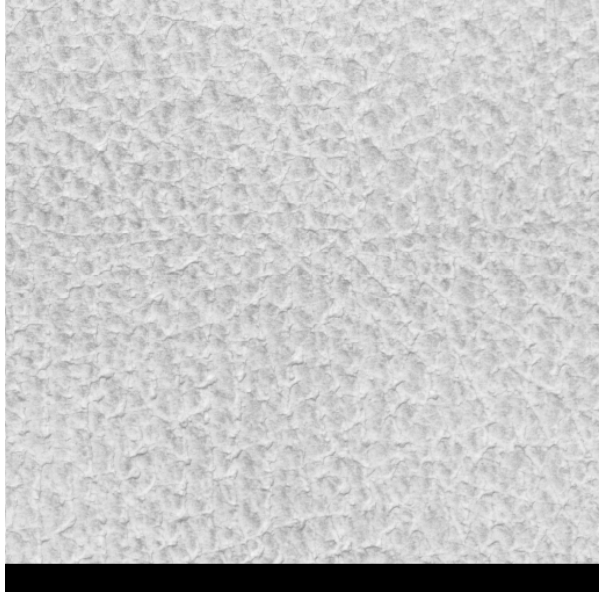
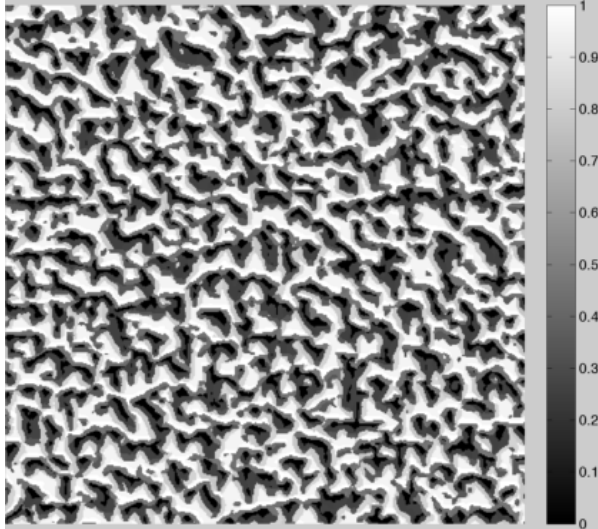
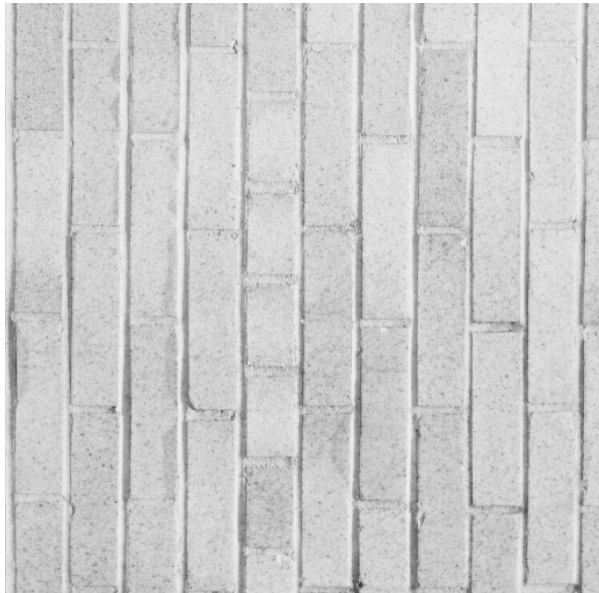



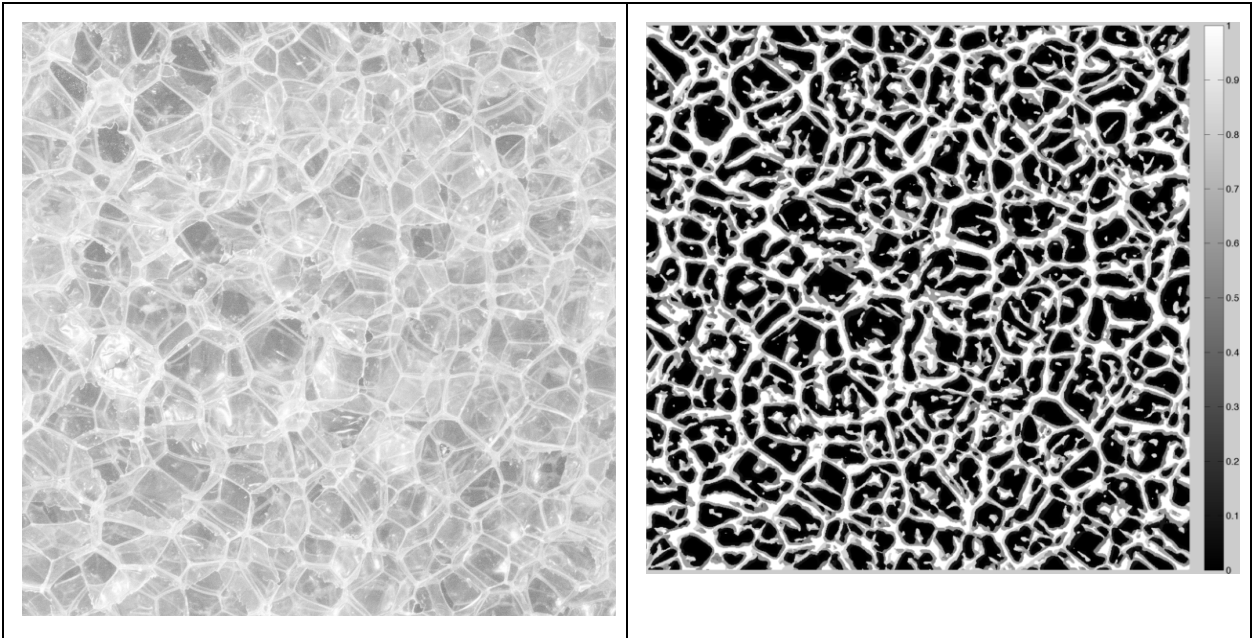


- Confusion Matrix for three filter banks

LM Filter Bank: Accuracy = 43.3929%	MR8 Filter Bank: Accuracy = 41.6071%
 <p>A confusion matrix for the LM Filter Bank. The x and y axes are labeled from 10 to 110 in increments of 10. A color bar on the right indicates values from 0 to 5. The matrix shows a strong diagonal line of high values (white/yellow) and scattered low values (dark gray) elsewhere.</p>	 <p>A confusion matrix for the MR8 Filter Bank. The x and y axes are labeled from 10 to 110 in increments of 10. A color bar on the right indicates values from 0 to 5. The matrix shows a strong diagonal line of high values (white/yellow) and scattered low values (dark gray) elsewhere.</p>
S Filter Bank Accuracy: 31.7857	
 <p>A confusion matrix for the S Filter Bank. The x and y axes are labeled from 10 to 110 in increments of 10. A color bar on the right indicates values from 0 to 5. The matrix shows a strong diagonal line of high values (white/yellow) and scattered low values (dark gray) elsewhere.</p>	

Texture Reconstruction

Original	Reconstructed
	
	



References

<http://www.cs.berkeley.edu/~malik/papers/LM-3dtexton.pdf>

(We implemented the 2D texton classification problem from the following paper)

Datasets & Filter Banks

1) Dataset to train and test texture model : Brodatz Texture Database

(<http://sipi.usc.edu/database/database.php?volume=textures>)

2) Filterbank for 2D texton extraction : The Leung-Malik Filterbank

(<http://www.robots.ox.ac.uk/~vgg/research/texclass/filters.html>)