Sharif University Of Technology

Advanced Topics in Neuroscience

Simulation 09 (Visual Model)

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Section 1: Sparse Basis Functions of the Natural Images

We have 10-natural-image and want to find the sparse bases function of them. At first, some basic pre-process need.For example, the contrast of all images have to be the same, so we normalize them. Then each images have to be prewhiten and delete high frequency content. One method is convolution of each image with the filter (to see its equation, look at the article). Then images are re scaled to have the specific average variance.

In figure 1, you see the 64 bases function with size of $8 * 8$ and the histogram of bases functions norm and variance of bases coefficients. The bases functions look like a gabor function. In other words, they are band-pass, localizes and oriented, as same as our $V1$ cells receptive field.

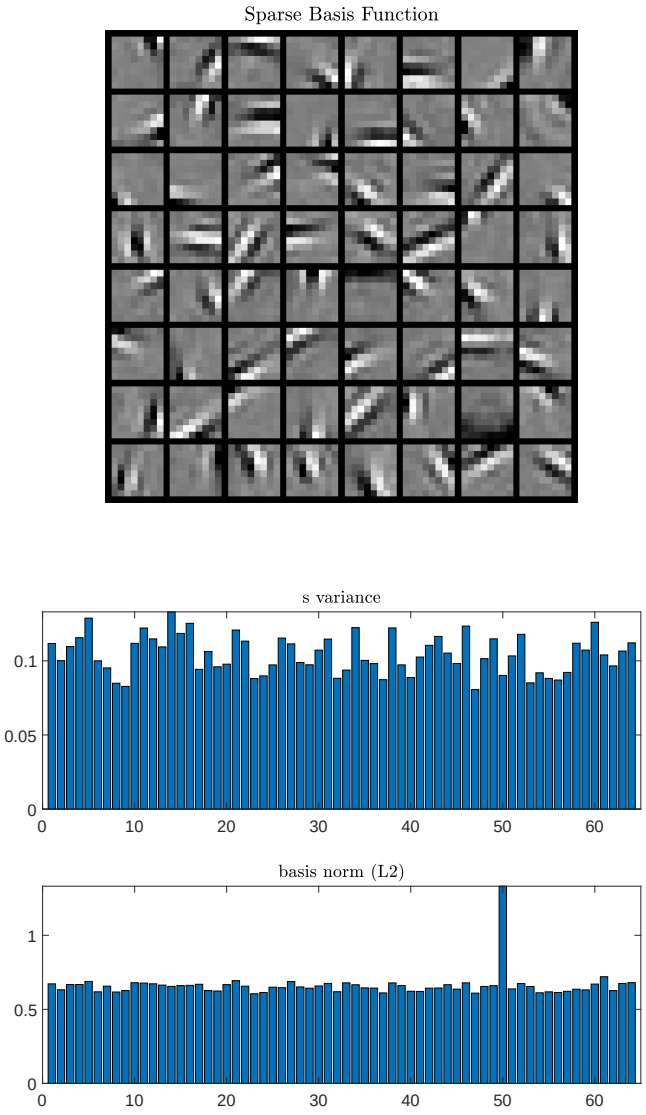


Figure 1: Sparse Bases Function of Natural Images

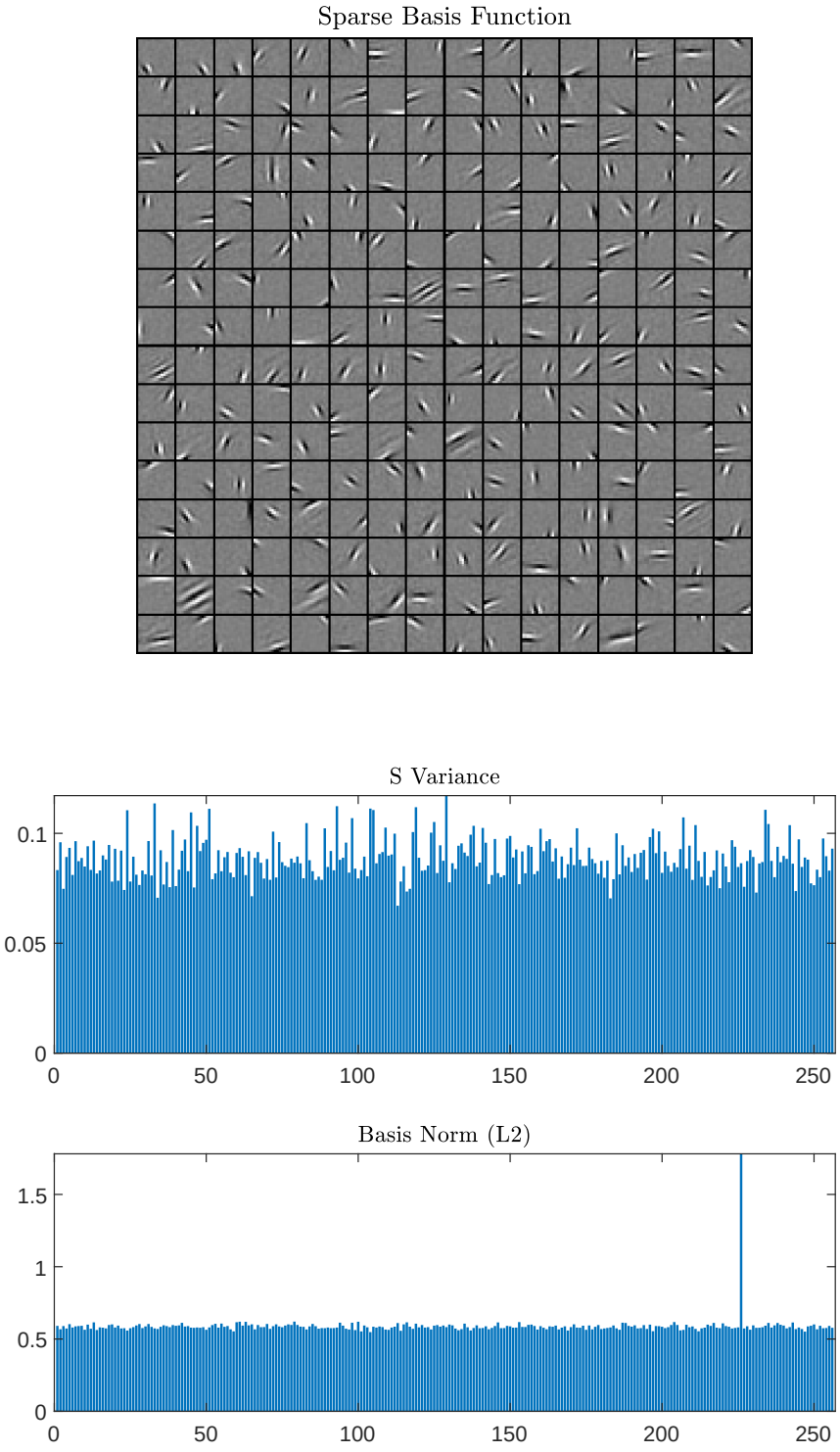


Figure 2: Sparse Bases Function of Natural Images

To see the effect of whitening, I run the method on original images. You can see the result in figure 3. It doesn't look like a $V1$ RF anymore. More bases function have the norm more than 0.5.

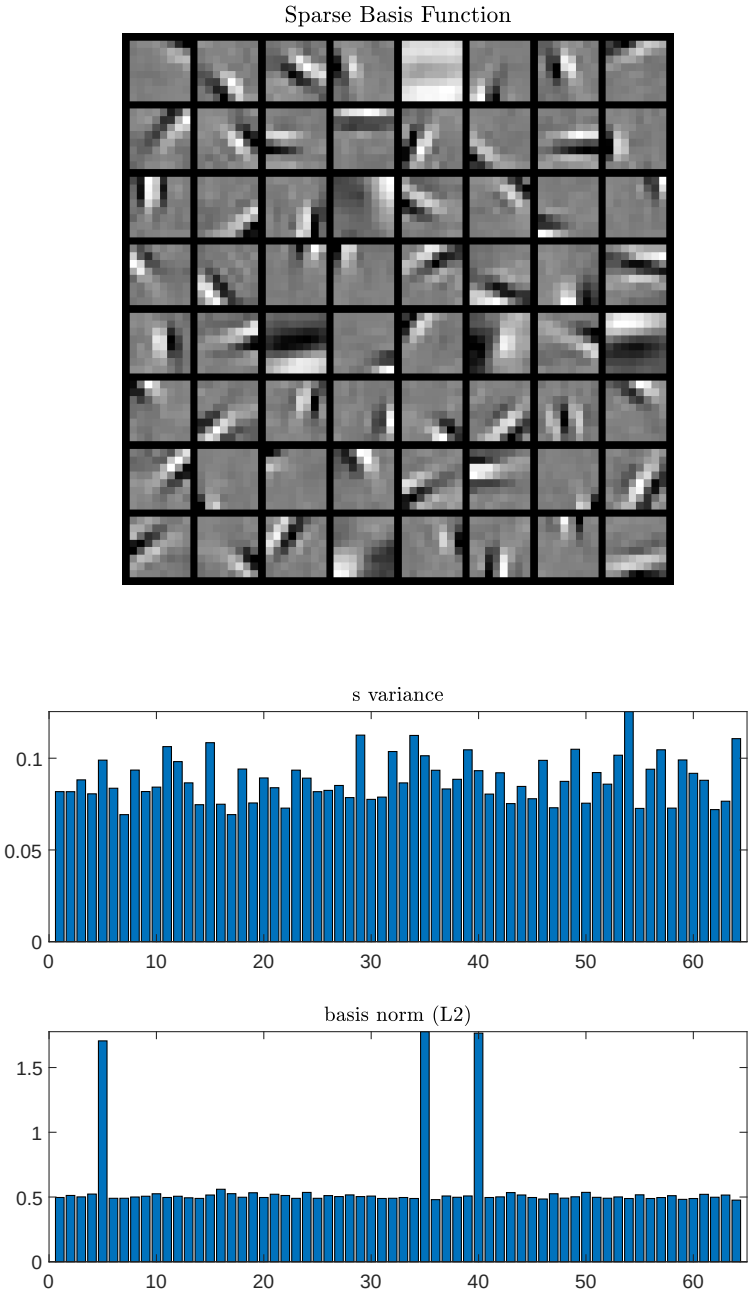


Figure 3: Sparse Bases Function of Natural Images

In figure 4, I show the bases function when the noise covarinace increase from 0.01 to 0.1. The coefficient variance increase and bases functions have higher norm.

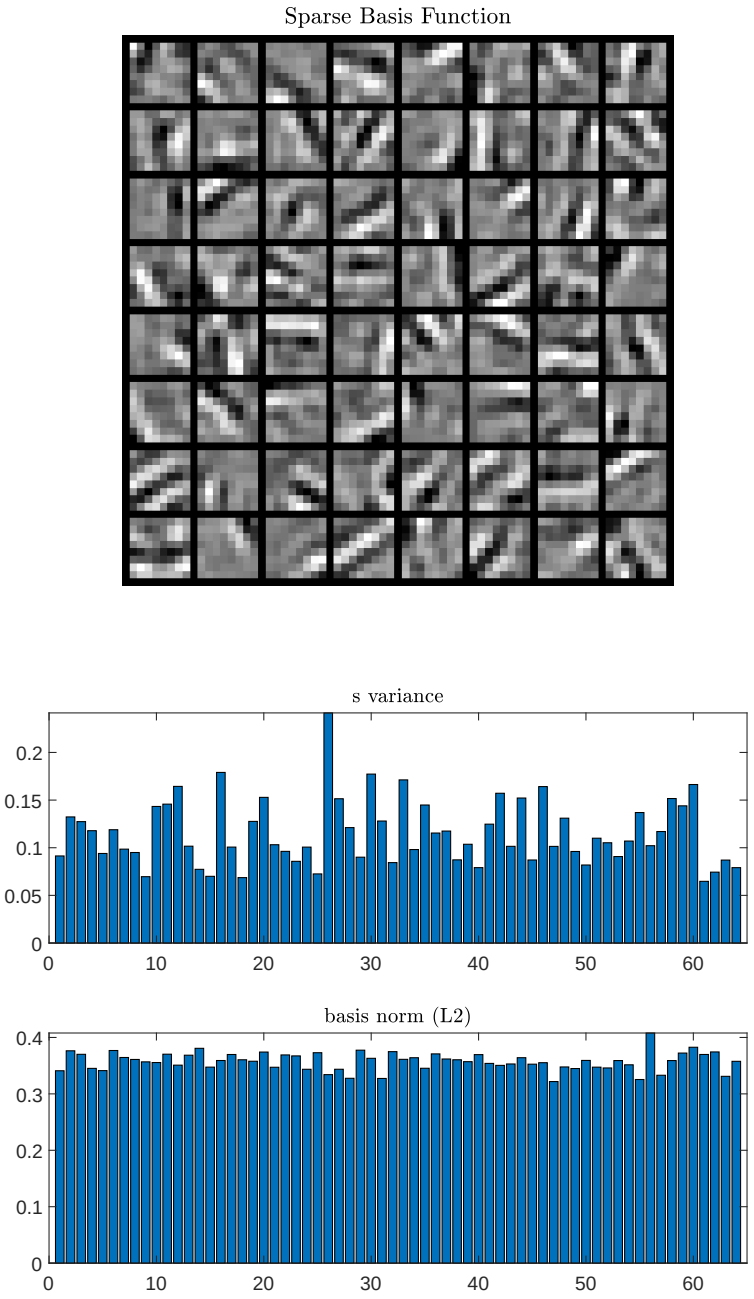


Figure 4: Sparse Bases Function of Natural Images

Section 2: Sparse Basis Functions of the Other Datasets

2.1 Yale face datasets

The Yale datasets which I used, has 15 face images, which face has 11 condition: "Normal, Center light, Right light, Left light, By glasses, No glasses, happy face, Sad face, Sleepy, Surprised and weak".

I randomly select 10 images (5) and pre-process them, as same as previous part. Now, the bases function of these image is found (figure **??**). Most of the bases function are not similar to gabor and have higher norm value.

Figure 5: Selected images from Yale datasets.

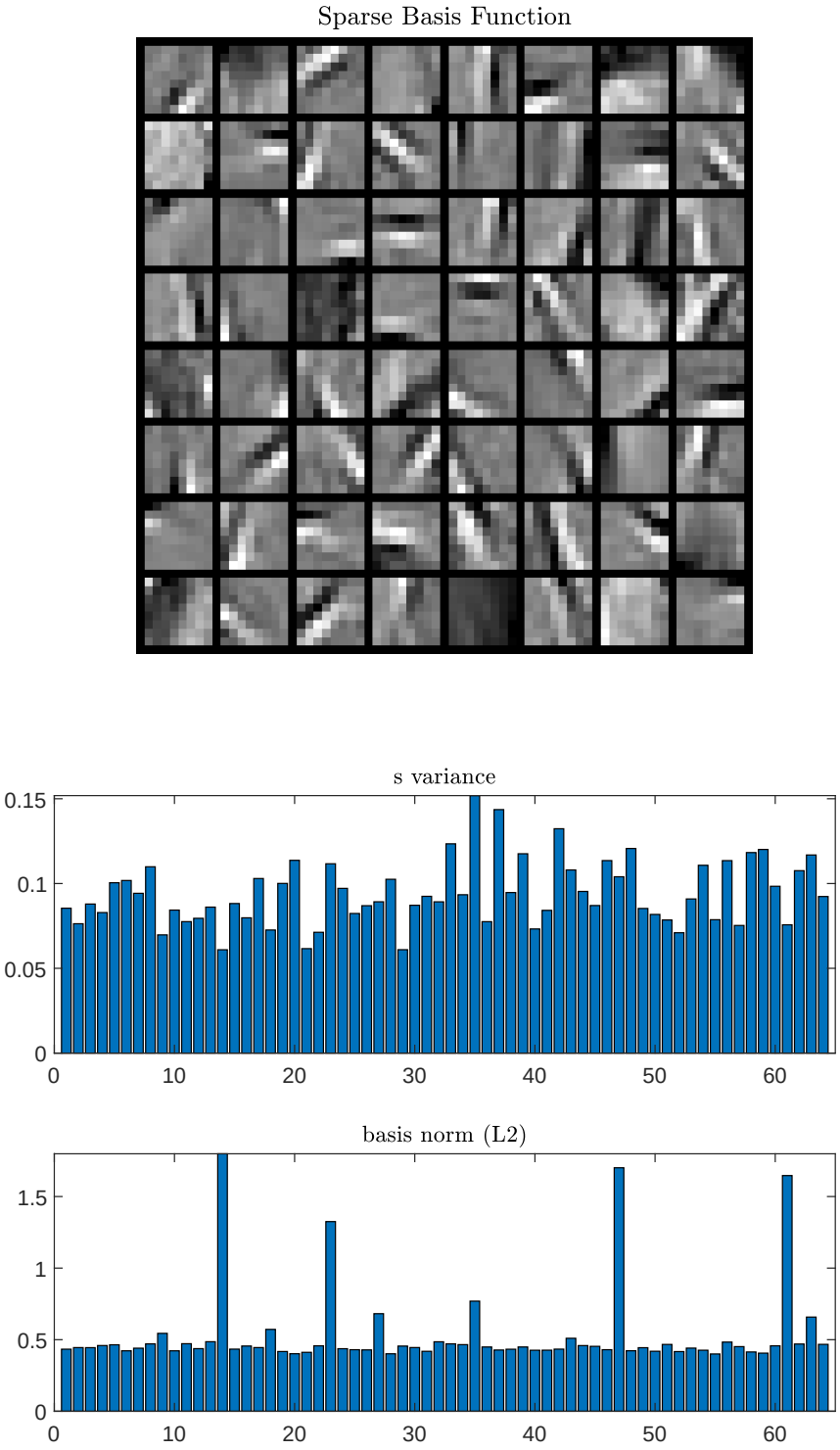


Figure 6: Sparse Bases Function of Yale datasets.

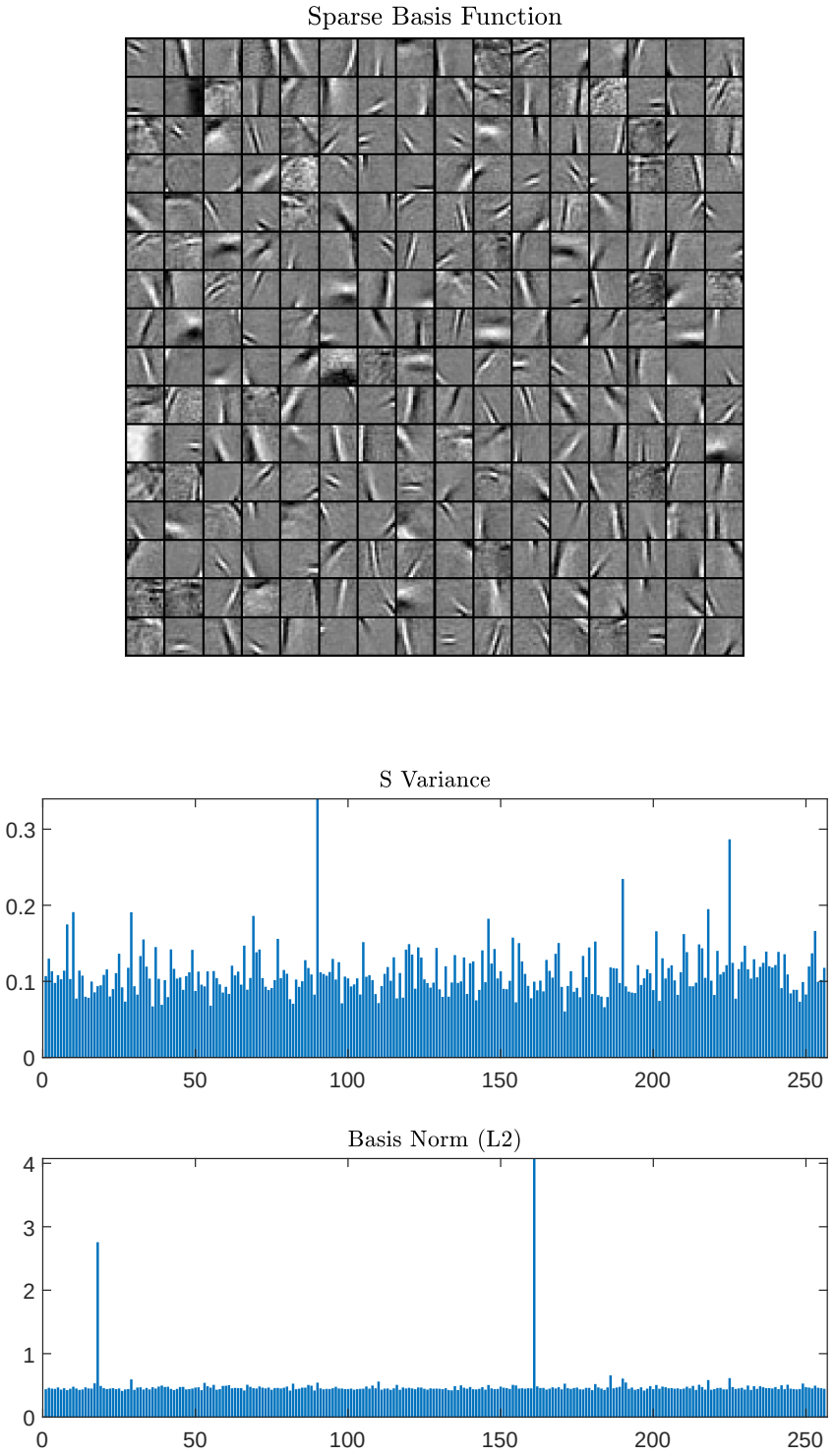


Figure 7: Sparse Bases Function of Yale datasets.

2.2 MNIST datasets

I randomly select 10 images and pre-process them, as same as previous part. Now, the bases function of these image is found (figure 8). Most of the bases function are not similar to gabor and have higher norm value.

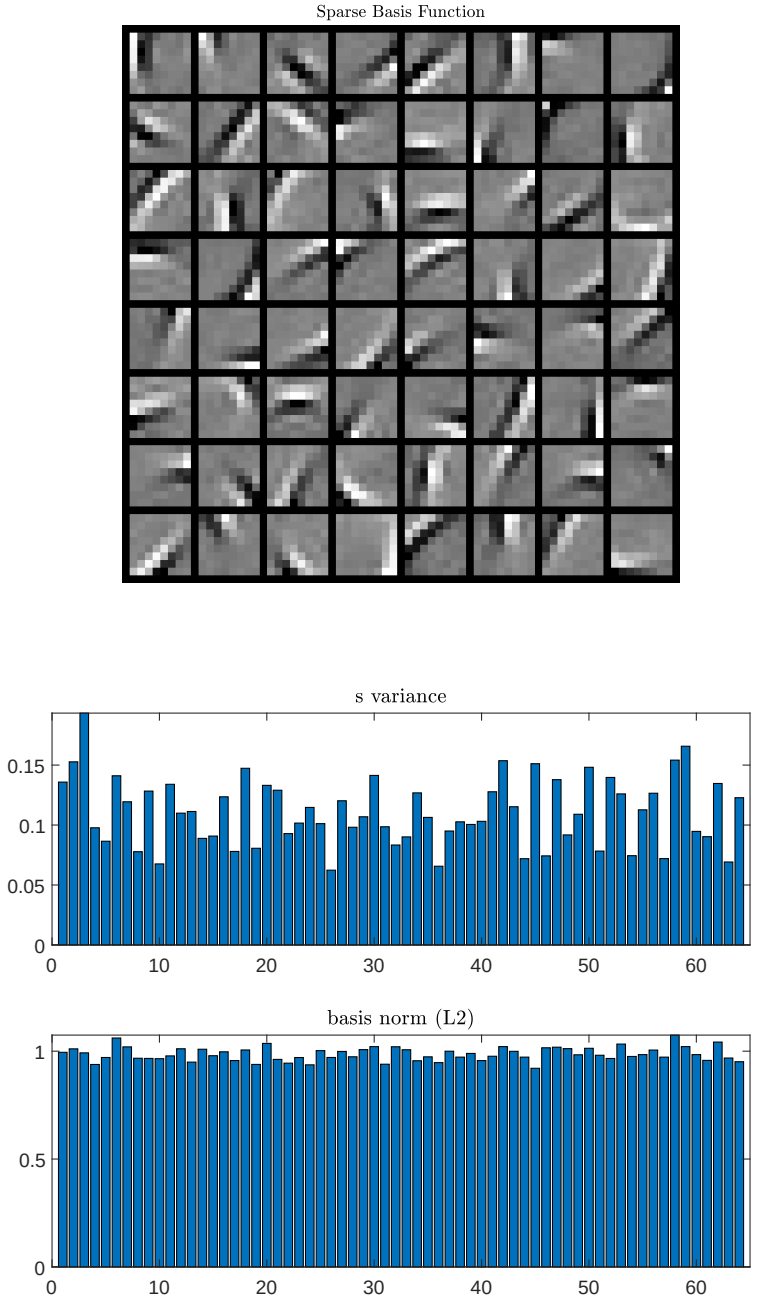


Figure 8: Sparse Bases Function of Yale datasets.

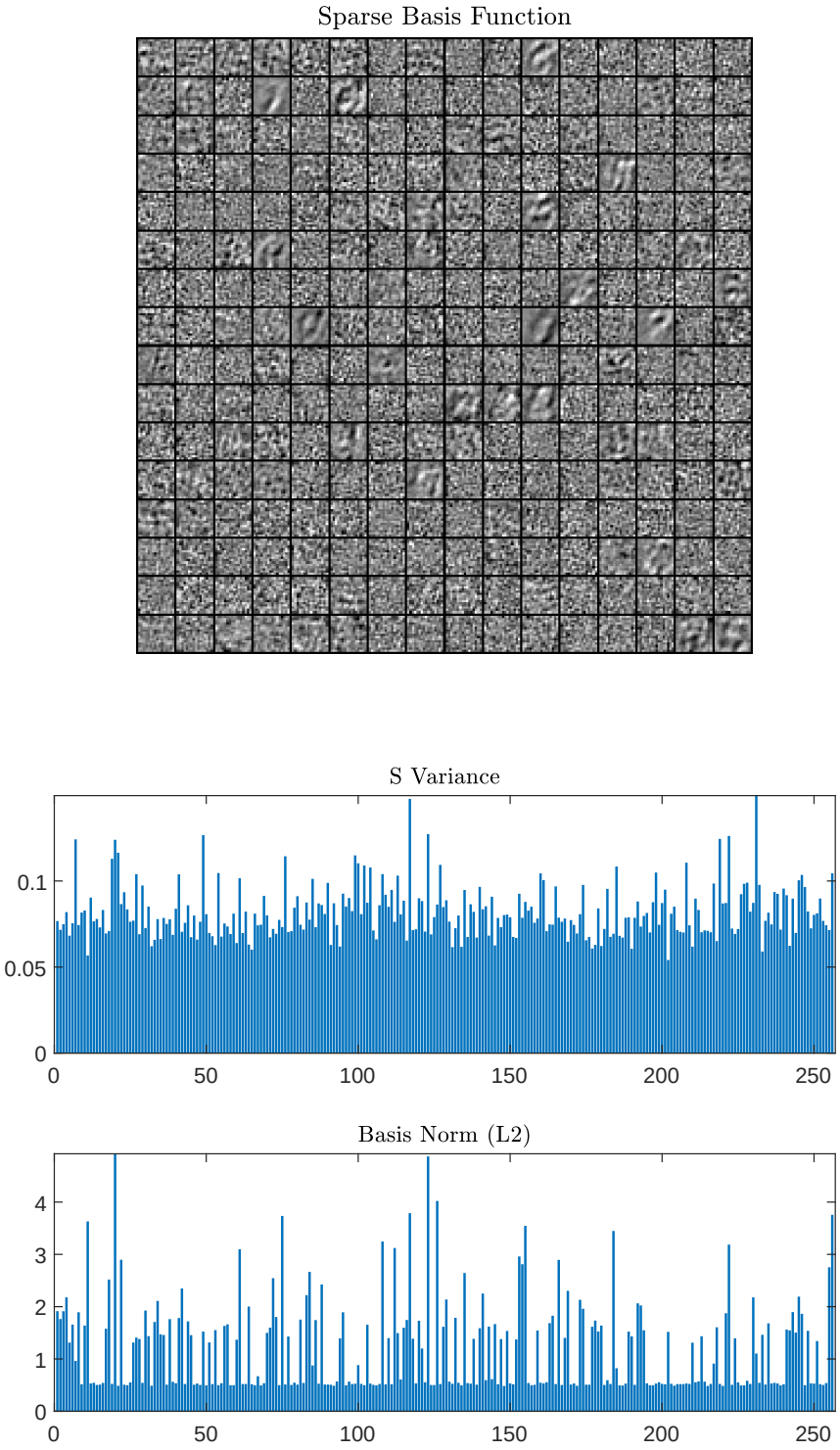


Figure 9: Sparse Bases Function of Yale datasets.

2.3 Caltech101 datasets

I randomly select 10 images (10) and pre-process them, as same as previous part. Now, the bases function of these image is found (figure 11). Most of the bases function are not similar to gabor and have higher norm value.

Figure 10: Selected images from Caltech datasets.

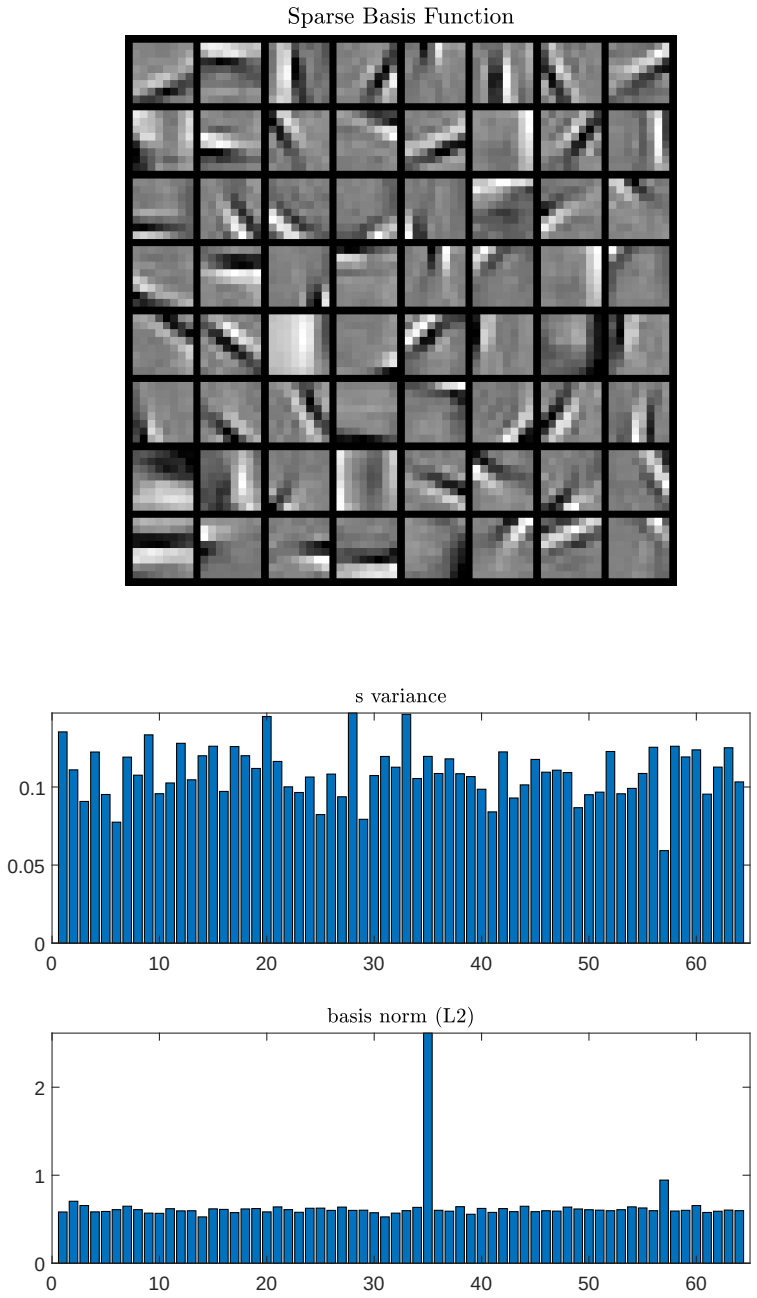


Figure 11: Sparse Bases Function of Caltech datasets.

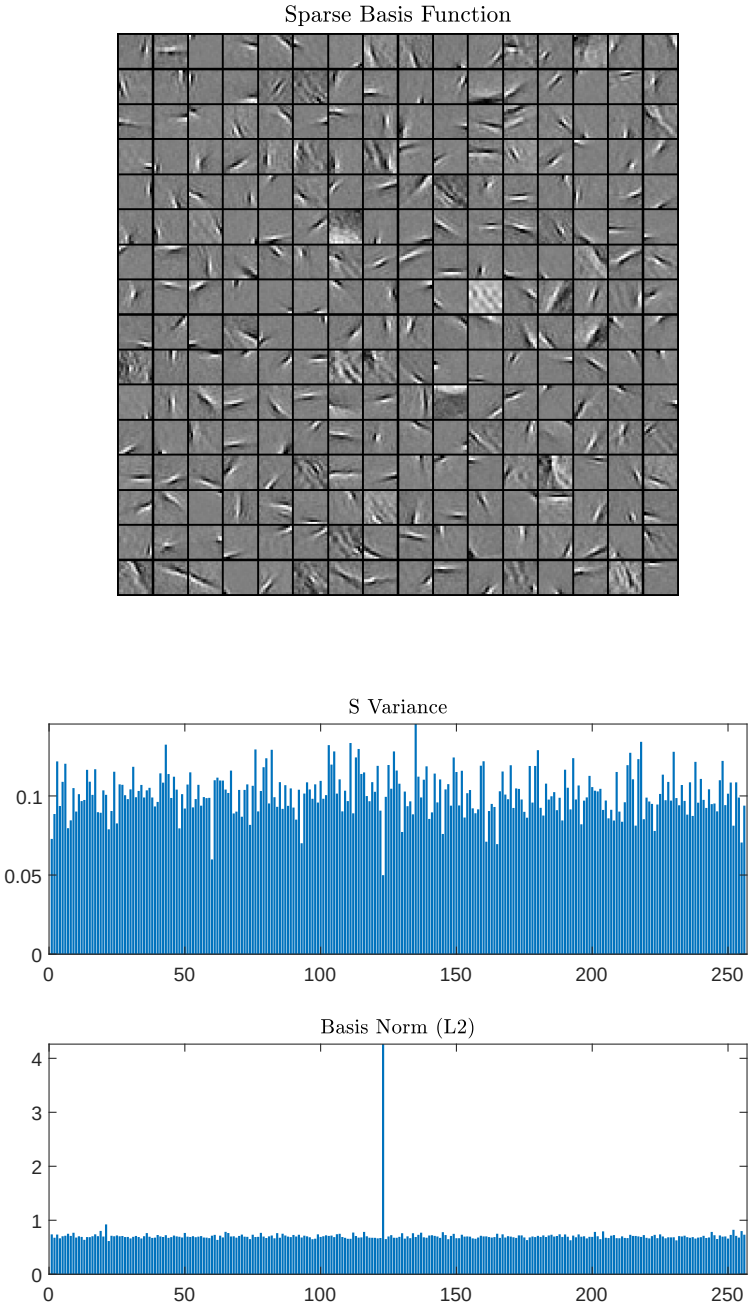


Figure 12: Sparse Bases Function of Caltech datasets.

I randomly choose 10 picture which are most related to nature. Again find the bases function (figure 13). There is no significant differences between them.

Figure 13: Selected images from Caltech datasets.

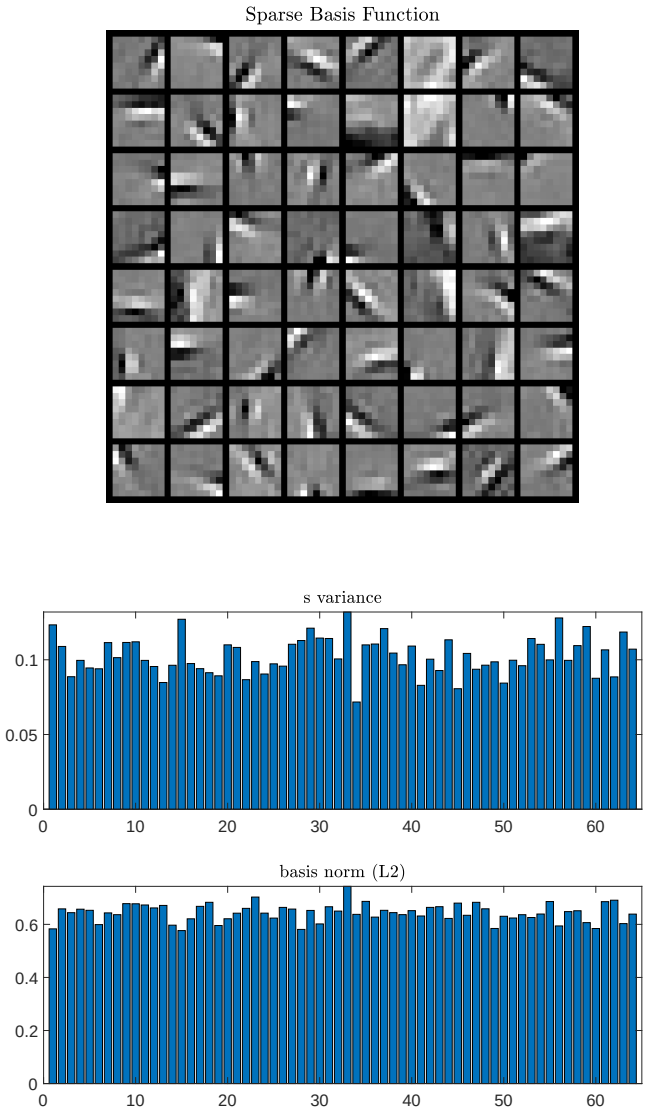


Figure 14: Sparse Bases Function of Caltech datasets.

Section 3: Dynamics of the Sparse Coefficients

The 'Bird' video has 118 frames. Every 10 frame is gotten and the bases function is found. I have a demo in link. You can see a final bases function of each image group in figure 15. We have different bases function over time.

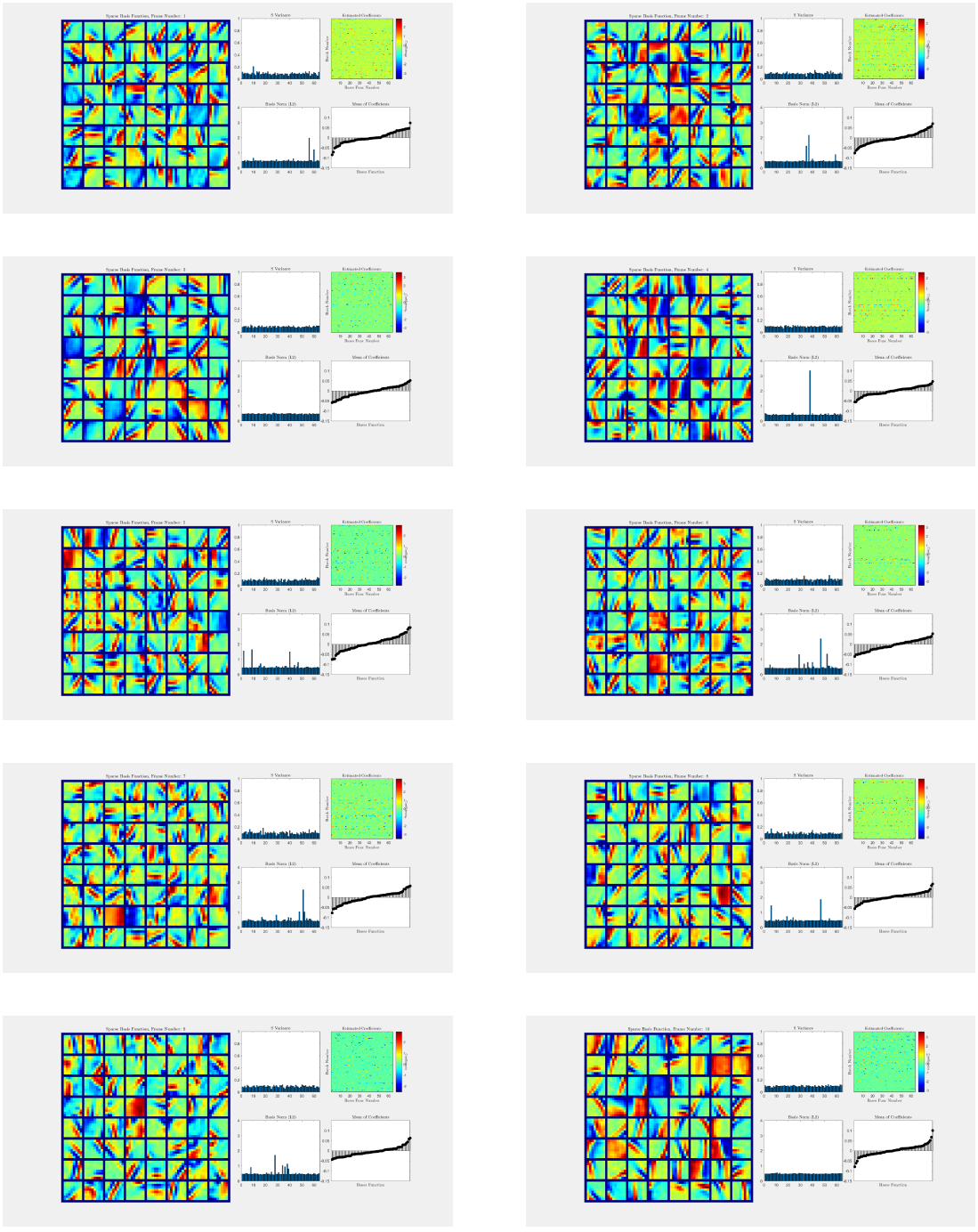
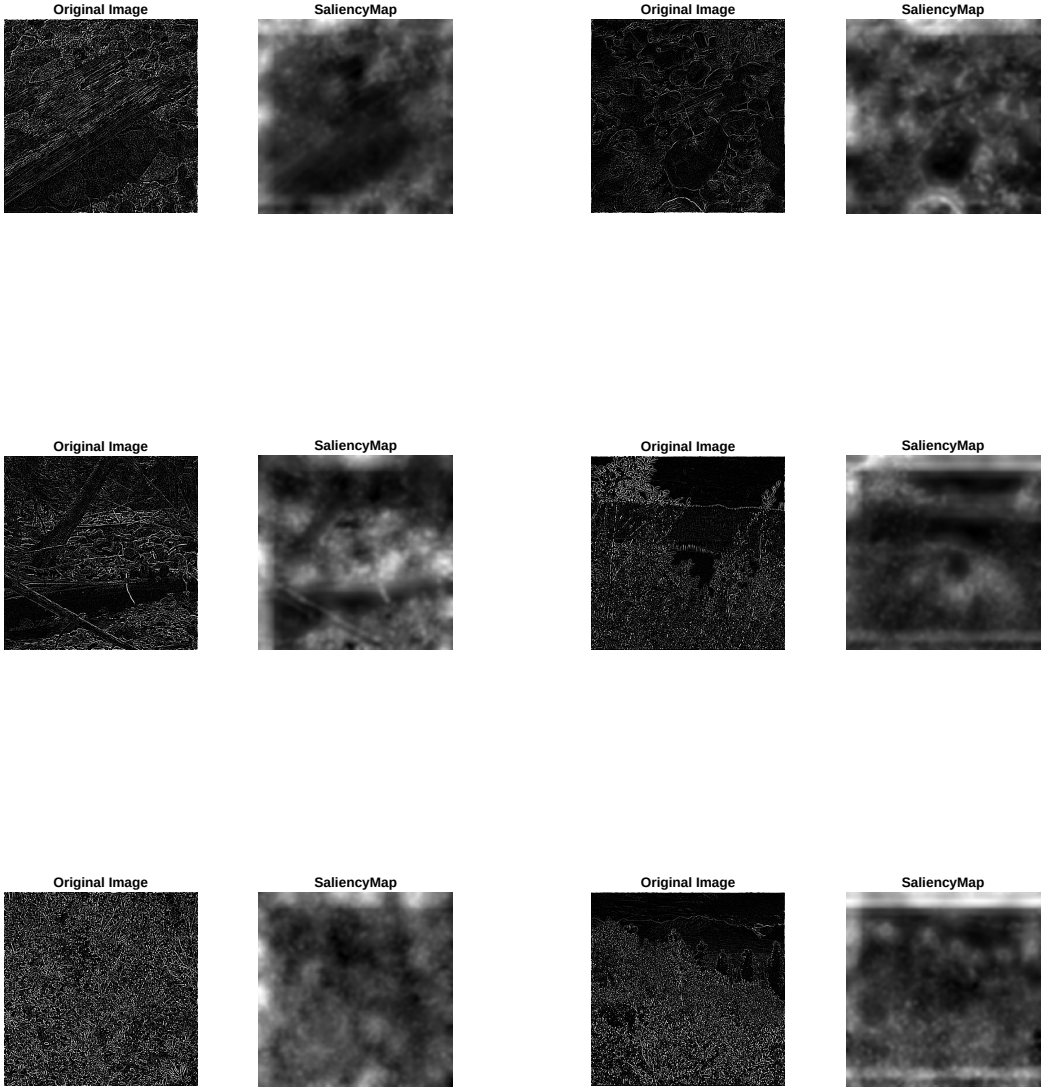


Figure 15: Sparse Bases Function.

Section 4: Sparse Basis Functions of Salience Map (Optional)

In this part, I run the sparse bases function on the image's salience map. We don't get the gabor function. So, the bases function is related to the image, not base on the image contrast. At first, the salience map of the natural image is shown in figure 16, and the bases function and the coefficient variance in figure .



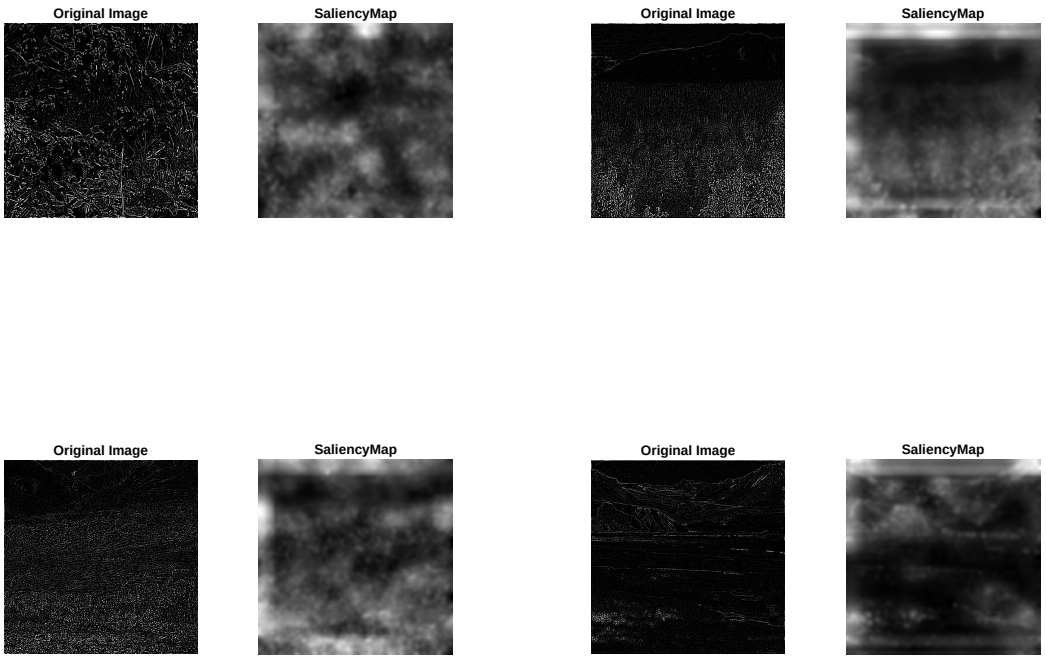


Figure 16: Selected images.

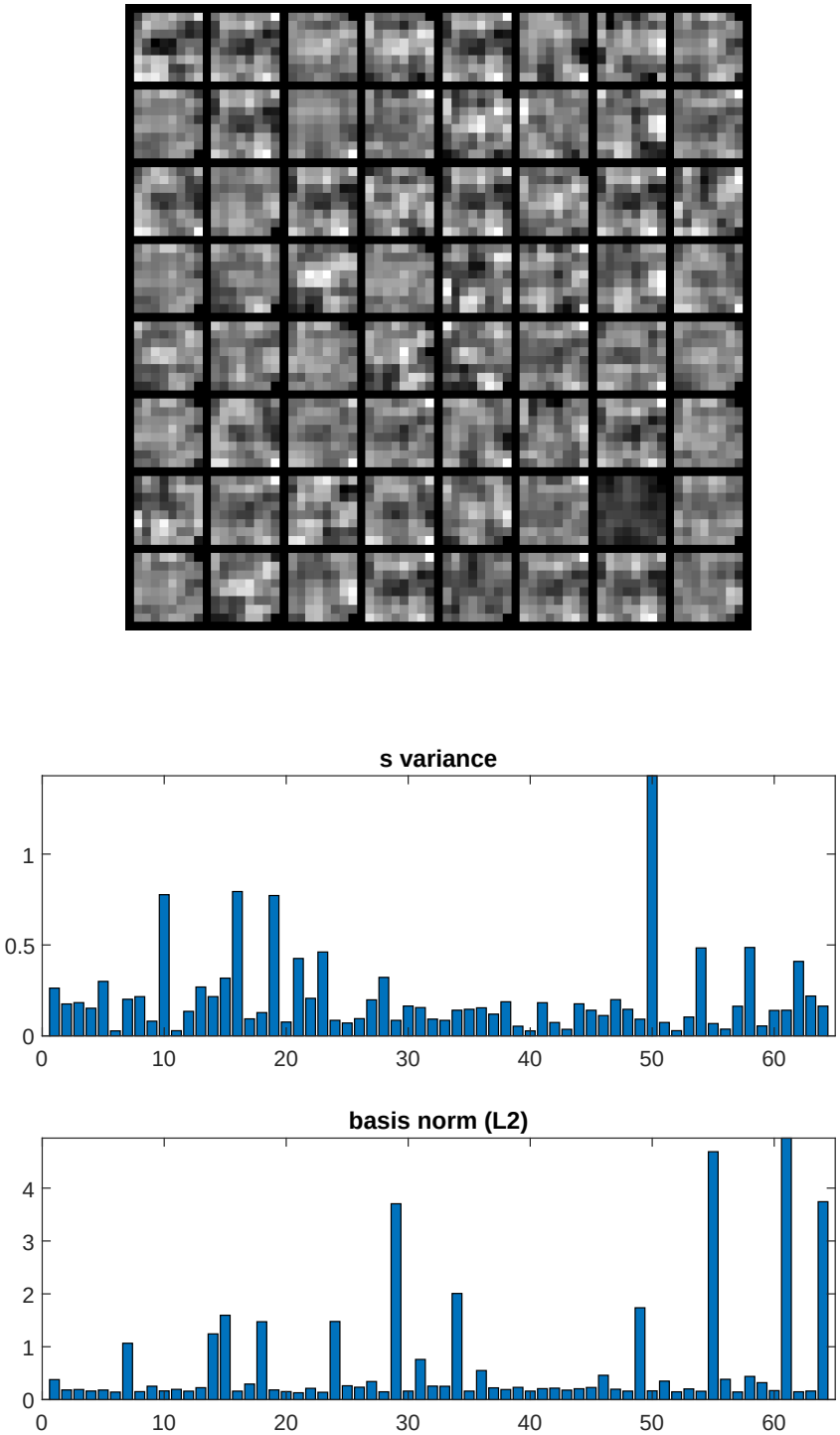


Figure 17: Sparse Bases Function.