Assignment-1

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1. **Motivation:**

   The experiment is to decompose a given 256x256 grayscale image matrix into product of matrices. There are many types of matrix decompositions. The following experiment is about Eigen Value Decomposition(EVD) and Singular Value Decomposition(SVD). We also understand the effects of dimension reduction(image compression).

2. **Description:**

   EVD is the decomposition of a square matrix into it's eigenvectors and eigenvalues. The experiment is to do the eigen decomposition and reconstruct the matrix from the constituent eigenvectors and eigenvalues. V contains the eigenvectors and Σ contains the corresponding eigenvalues.

   $$A = V.\Sigma.V^{-1}$$

   SVD is the decomposition of any mxn matrix into several components which show several useful features of the original matrix. U is the left singular matrix(contains eigenvectors of AA^t), Σ contains the singular values and V is the right singular matrix(contains eigenvectors of A^tA).
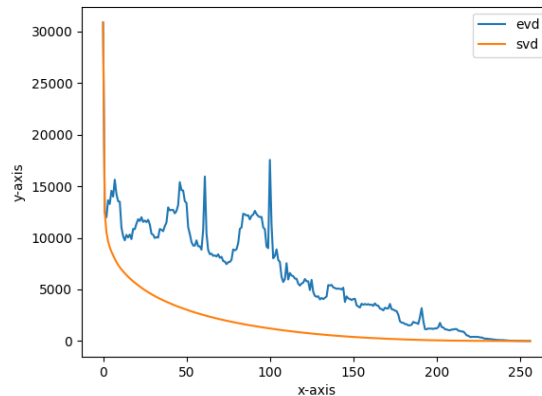
   $$A = U.\Sigma.V^t$$

3. **Experiment results**

Figure 1: Frobenius norms vs K graph
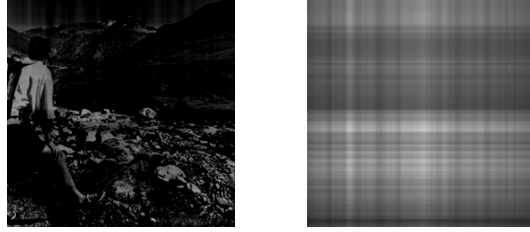
Error image vs Reconstructed image (SVD) :

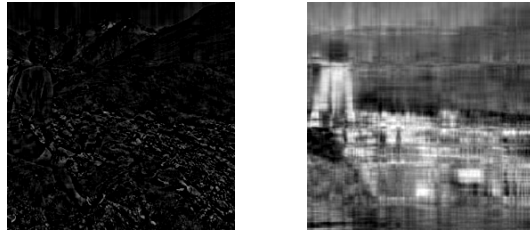Figure 2: Error image(left) and Reconstructed image(right) for k = 1

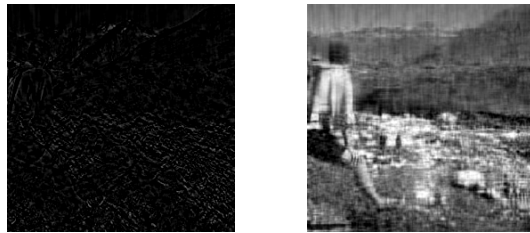Figure 3: Error image(left) and Reconstructed image(right) for k = 10

Figure 4: Error image(left) and Reconstructed image(right) for k = 20

Figure 5: Error image(left) and Reconstructed image(right) for k = 50

Figure 6: Error image(left) and Reconstructed image(right) for k = 100
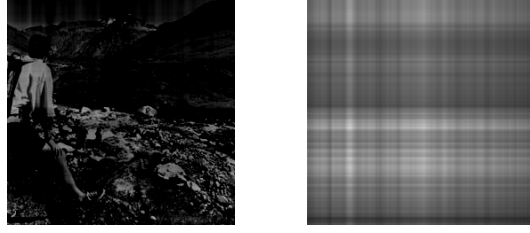
Error image vs Reconstructed image (EVD) :

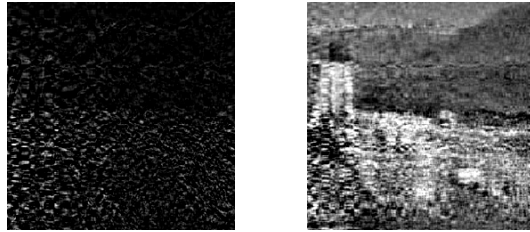Figure 7: Error image(left) and Reconstructed image(right) for k = 1

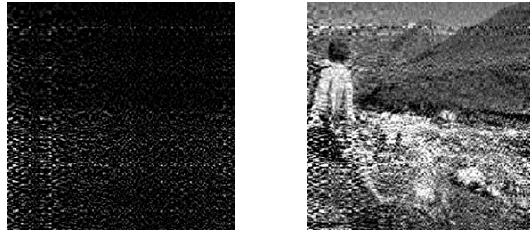Figure 8: Error image(left) and Reconstructed image(right) for k = 20

Figure 9: Error image(left) and Reconstructed image(right) for k = 50
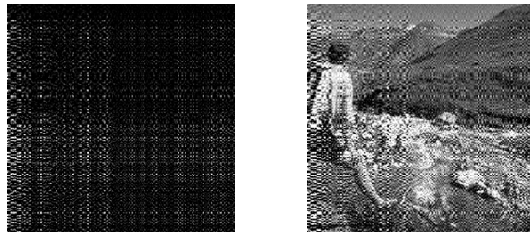

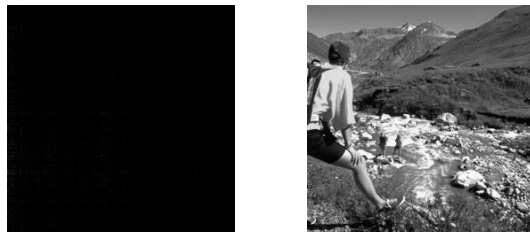Figure 10: Error image(left) and Reconstructed image(right) for k = 100

Figure 11: Error image(left) and Reconstructed image(right) for k = 200

4. **Inference:**

In the graph we can see the norm of the (original image - reconstructed image) for SVD lies much below than SVD. Clearly, from the above results we can see that SVD gives much better results than EVD for the same value of k. Few observations that differ SVD from EVD are listed below,

$\rightarrow$ In the case of SVD we can see the image is a lot clearer for k > 50 which is not case for EVD (k > 180 makes the image clear enough).

$\rightarrow$ In SVD the diagonal matrix Σ are all non-negative real values whereas in EVD the entries of Σ can be complex or real.

$\rightarrow$ We can see the graph of EVD going up and down(sharp spikes) which makes the model not reliable because of the unstable behaviour.