

REPORT-

Question 1-

PCA or Principal Component Analysis is a concept derived from Linear Algebra and it helps in data compression, noise reduction in the dataset, data visualisation and data analysis.

An image is basically a matrix- a grid of pixels where each pixel has a different intensity.

Following are the steps that we undertake to compress an image-

- When we apply PCA to an image for image compression, we discard some of the information and the dimension reduces to a smaller number of Principal components (PCs).
- We then reconstruct the image using reduced number of PCs
- Then check for different values of selected components that how good of an image we can reconstruct using reduced PCs.

We first import the required libraries, our image to be compressed and then display the image. The image that we have imported is an RGB (colour) image meaning it has data in 3 channels and although we can work in 3 matrices also, to make our job easier we convert it to a greyscale image. Then we perform PCA on the original matrix having all the components present. From the output plot on the screen, we then see how many components could be retained and how many of them have a cumulative variance. We then decide a suitable number of components that represent the image for compression.

OBSERVATION-

We can observe from taking different number and variety of PCs that as number of components used for reconstruction of image is increased, the clarity of image and its resemblance to the original grayscale image increases.

Question 2-

For image reconstruction using Singular Value Decomposition (SVD), we take an image and add Gaussian and uniform noise to it and then reconstruct it.

Gaussian noise is a term used in signal processing theory denoting a single noise which has a probability density function equal to that of normal distribution.

Uniform noise means different values of noise are equally probable.

When we are reconstructing using SVD, we take three variables, u , s and v and make it into SVD from `np.linalg.svd(gray image, full_matrices=False)`.

We then find the Variance experienced by top 20 singular values which is essentially checking the values for different values of k .

As most of the variance is contained in top few eigen vectors, we use some top values of k for reconstruction of image to obtain a clear image. For example, using only the topmost eigen vector will not yield a clear image but using top 15 r top 20 eigen vectors may yield a clear image.

To reconstruct image using Discrete Fourier Transformation, we use the FFT Function to reconstruct image.

OBSERVATION-

Most of the information is contained in the low frequency waves and the information of the edges are contained by the high frequency waves.