# SPATIAL-SPECTRAL PROCESSING, FEATURE EXTRACTION AND CLASSIFICATION OF MNIST AND FASHION MNIST DATASETS

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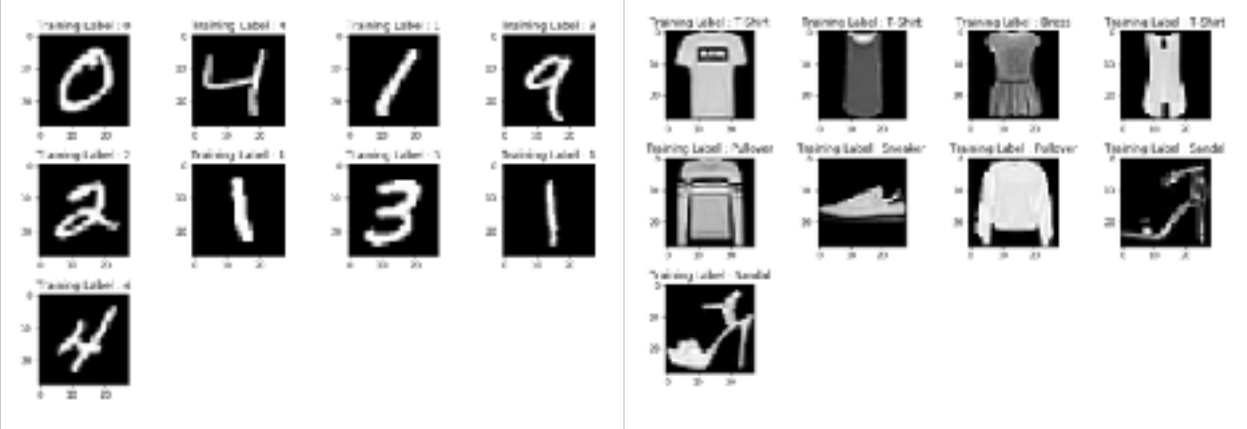
## TABLE OF CONTENTS

## INTRODUCTION

In my project, I have used MNIST dataset which comprises of hand-written digits and Fashion MNIST which comprises of clothing images. Both the dataset are of the same dimension and size i.e. 28X28 and 70,000 images. The images shown below depicts the sample images of MNIST and Fashion MNIST dataset.



| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

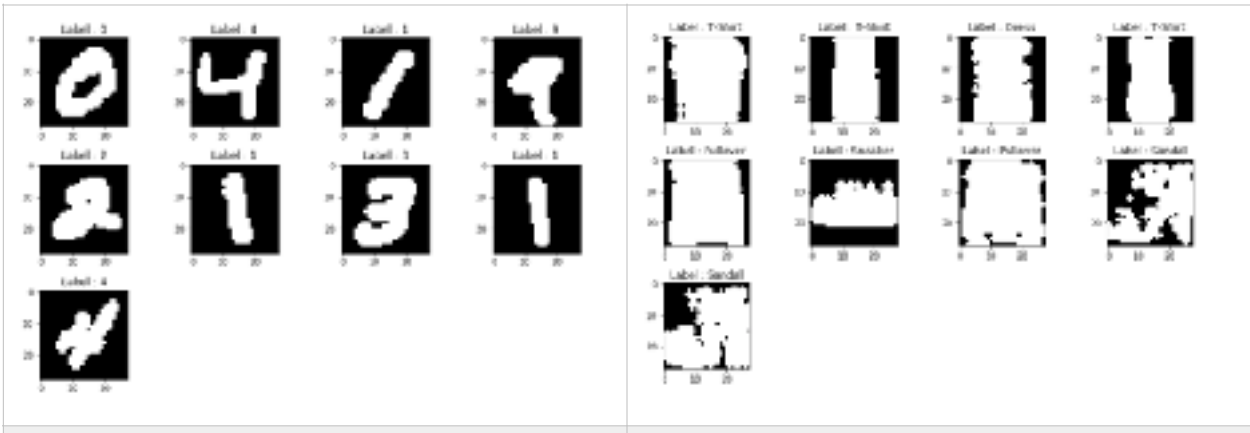
**Figure 1 : Sample images of MNIST(left) AND Fashion MNIST(right) dataset.**

## PROCESSING TECHNIQUES

## SPATIAL PROCESSING TECHNIQUES

### 1. DILATION

The basic effect of the operator on a binary image is to gradually enlarge the boundaries of regions of foreground pixels(*i.e*. white pixels, typically). Thus areas of foreground pixels grow in size while holes within those regions become smaller.

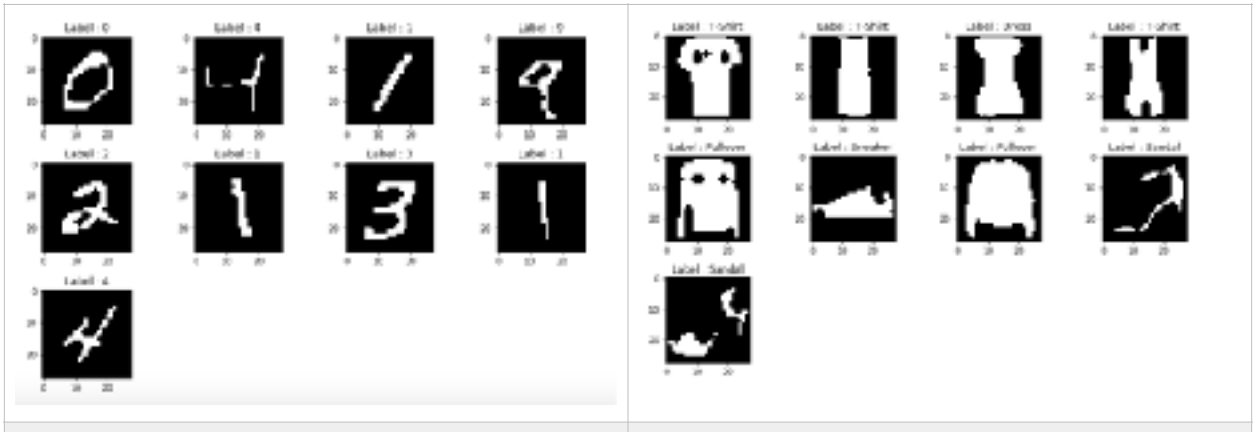


| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 2 : Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation.**

## 2. EROSION

The basic effect of the operator on a binary image is to erode away the boundaries of regions of foreground pixels (*i.e*. white pixels, typically). Thus areas of foreground pixels shrink in size, and holes within those areas become larger.



| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

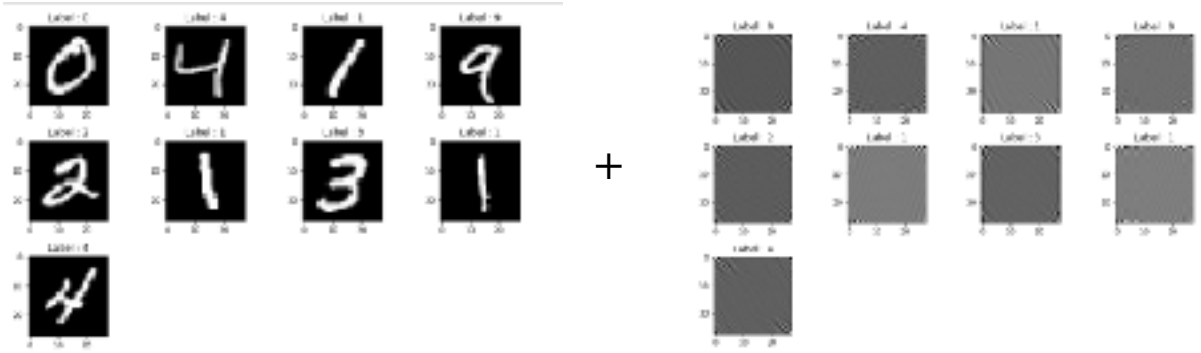
**Figure 3 : Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion.**

## SPECTRAL PROCESSING TECHNIQUES

### 1. FOURIER TRANSFORM

The Fourier Transform is an important image processing tool which is used to decompose an image into its sine and cosine components. The output of the transformation represents the image in the Fourier or frequency domain, while the input image is the spatial domain equivalent.

**Original Image** **Fourier Transform**



**Reconstructed Image**

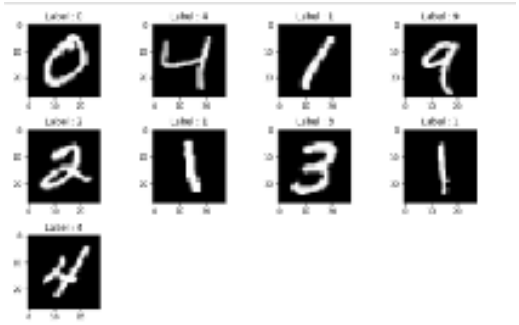
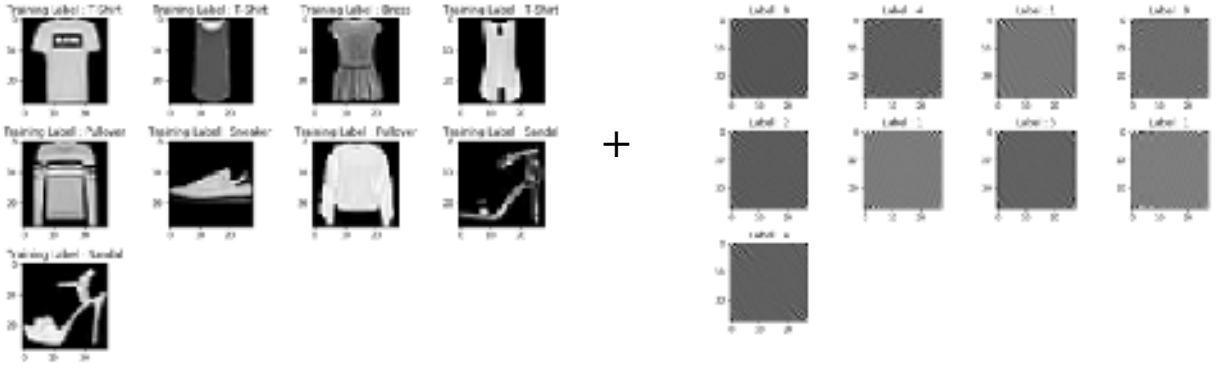


**Figure 4 : Sample images of MNIST dataset after applying Fourier Transform.**

**Original Image** **Fourier Transform**



=

**Reconstructed Image**

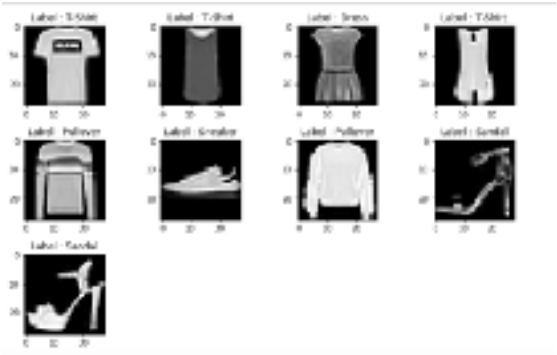


**Figure 5 : Sample images of Fashion MNIST dataset after applying Fourier Transform.**

## 2. PRINCIPAL COMPONENT ANALYSIS

It is used to compress high dimension data to low dimension data space. The size of the data was reduced from 784 components to 154 components.

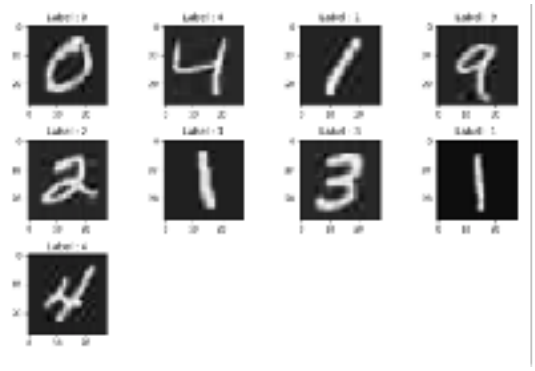
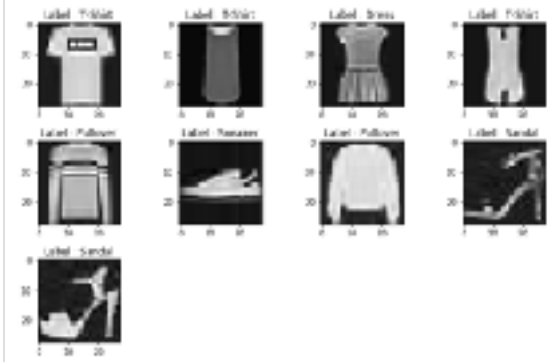
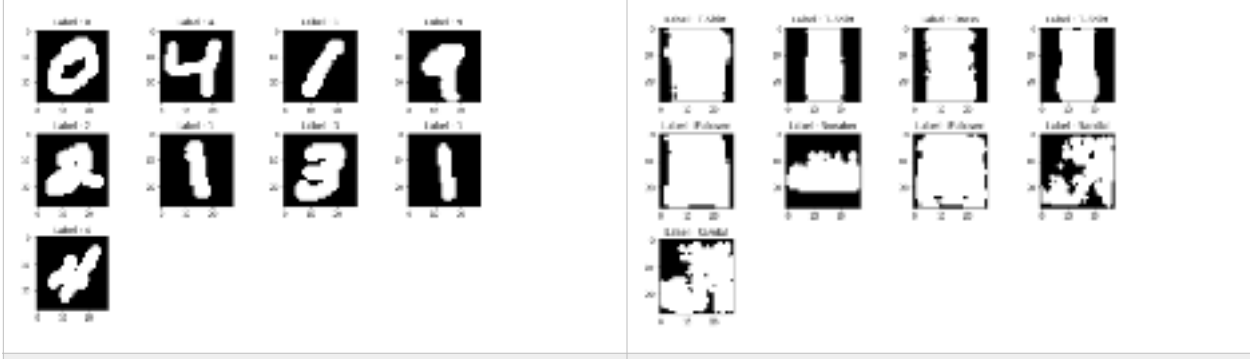
| | |
|---|---|
|  |  |
| **MNIST Dataset** | **Fashion MNIST Dataset** |

**Figure 6 : Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying PCA.**

## SPATIAL-SPECTRAL PROCESSING TECHNIQUES

This section comprises of the combination of techniques used for spatial-spectral processing on the MNIST and Fashion MNIST Dataset

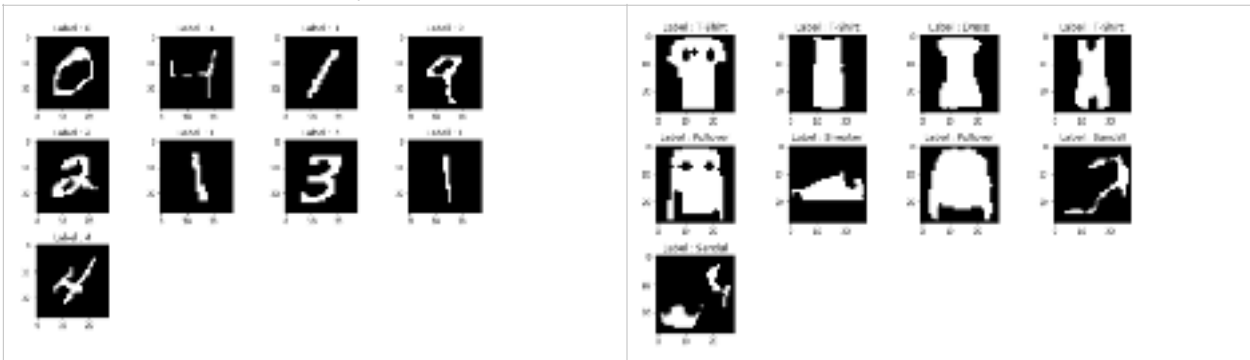
### 1. Dilation followed by Fourier Transform



| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 7: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation followed by Fourier Transform.**

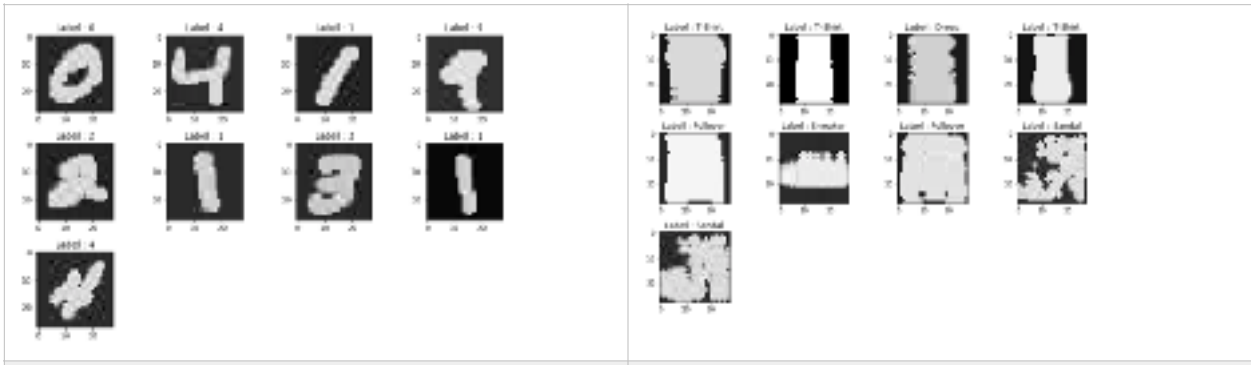
### 2. Erosion followed by Fourier Transform



| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 8: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion followed by Fourier Transform.**

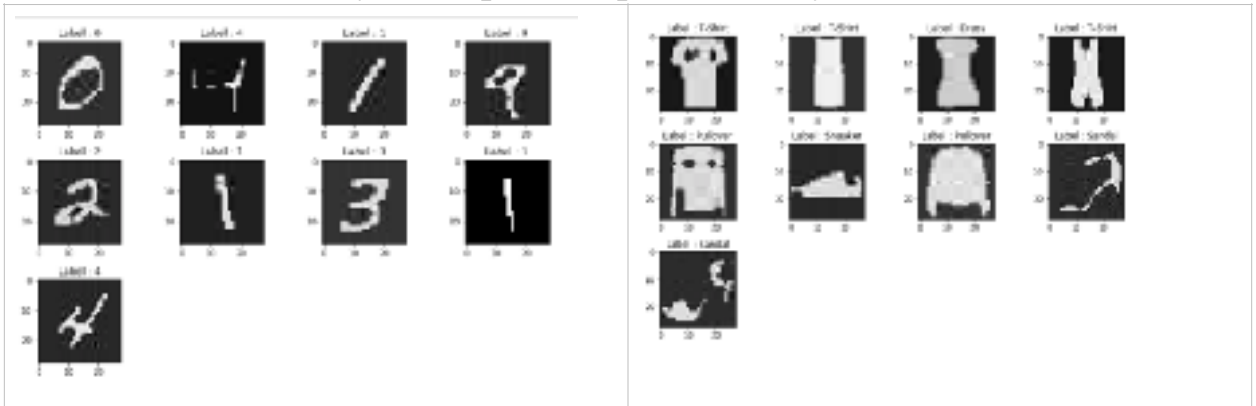
## 3. Dilation followed by Principal Component Analysis



| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 9: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation followed by Principal Component Analysis.**

## 4. Erosion followed by Principal Component Analysis



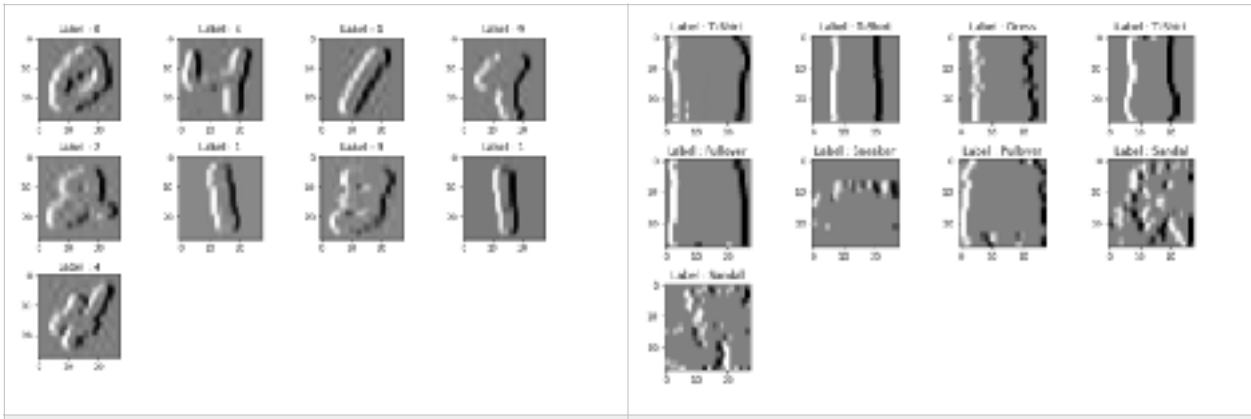
| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 10: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion followed by Principal Component Analysis.**

## FEATURE EXTRACTION METHODS

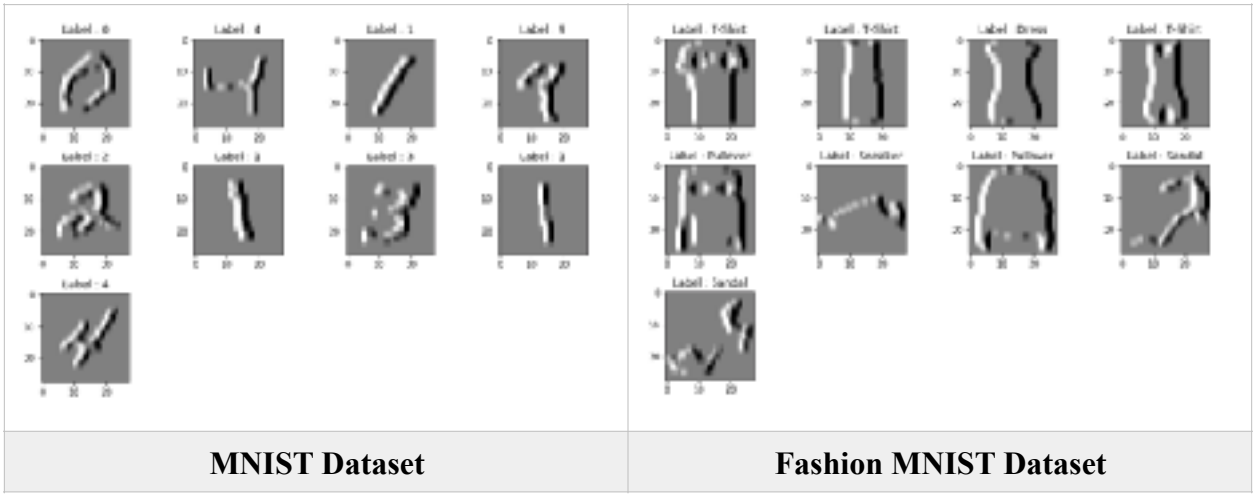
## SOBEL EDGE DETECTOR METHOD

It is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Sobel–Feldman operator is either the corresponding gradient vector or the norm of this vector.



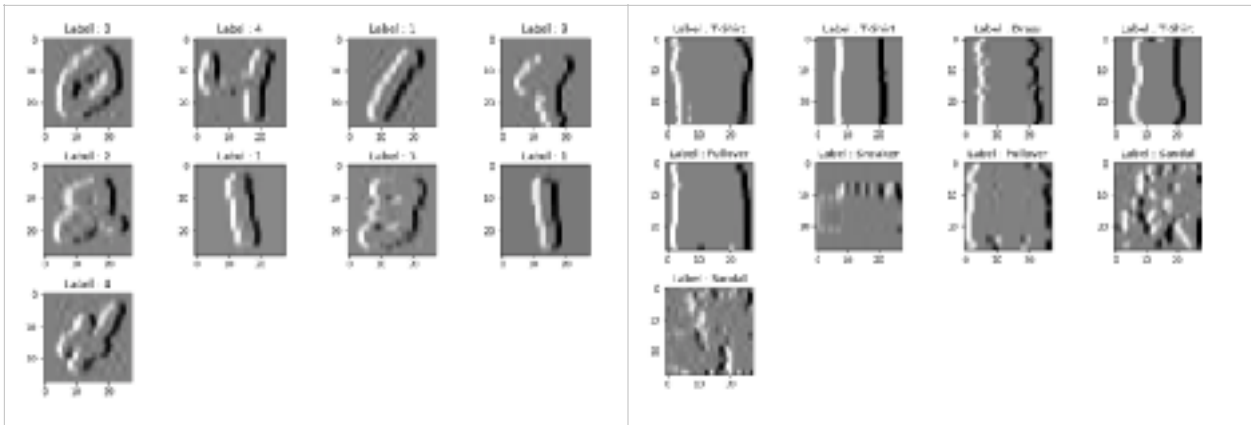
| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 11: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation followed by Fourier Transform and Sobel Edge Detector.**



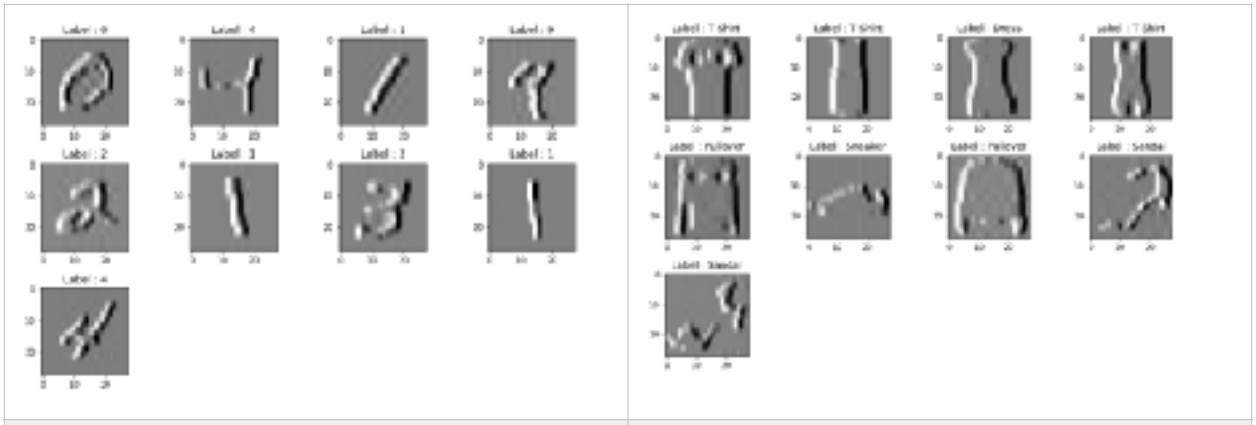
| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 12: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion followed by Fourier Transform and Sobel Edge Detector.**



| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 13: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation followed by Principal Component Analysis and Sobel Edge Detector.**

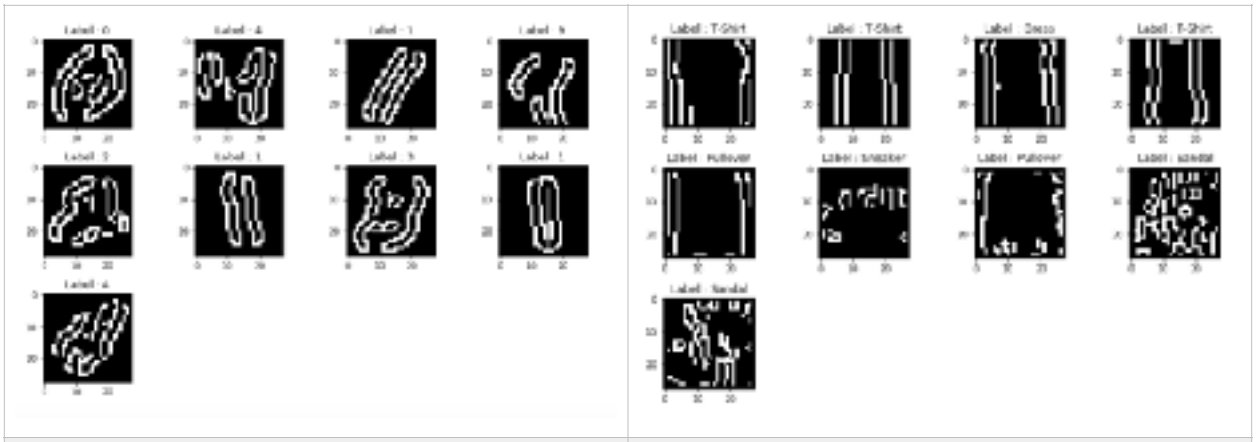


| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 14: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion followed by Principal Component Analysis and Sobel Edge Detector.**

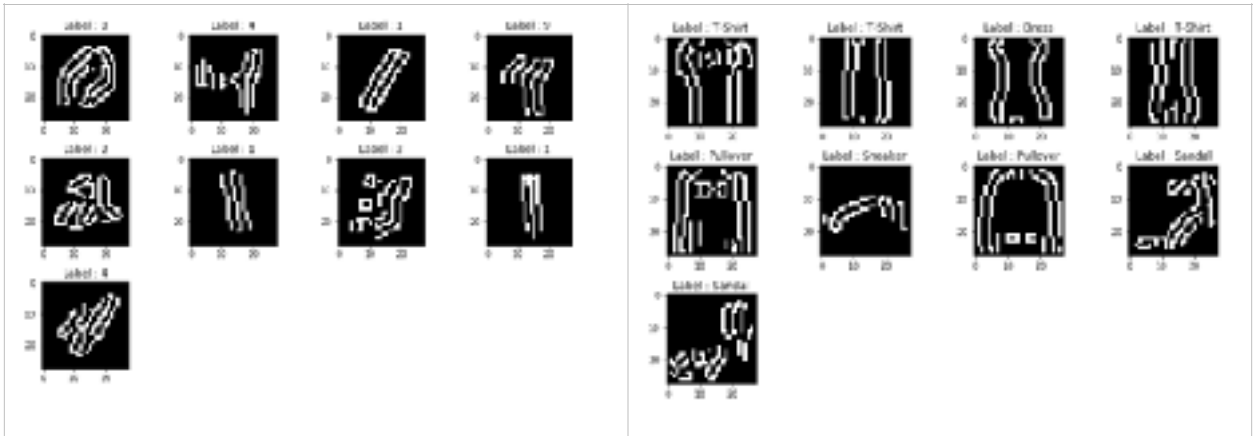
## CANNY EDGE DETECTOR METHOD

The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images. It uses a filter based on the derivative of a Gaussian in order to compute the intensity of the gradients.The Gaussian reduces the effect of noise present in the image.



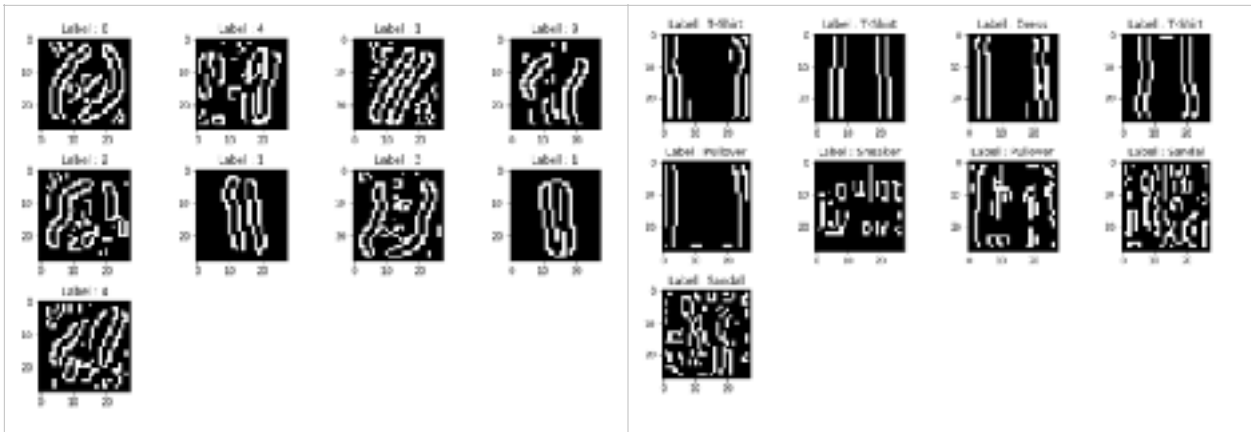
| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 15: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation followed by Fourier Transform and Canny Edge Detector.**



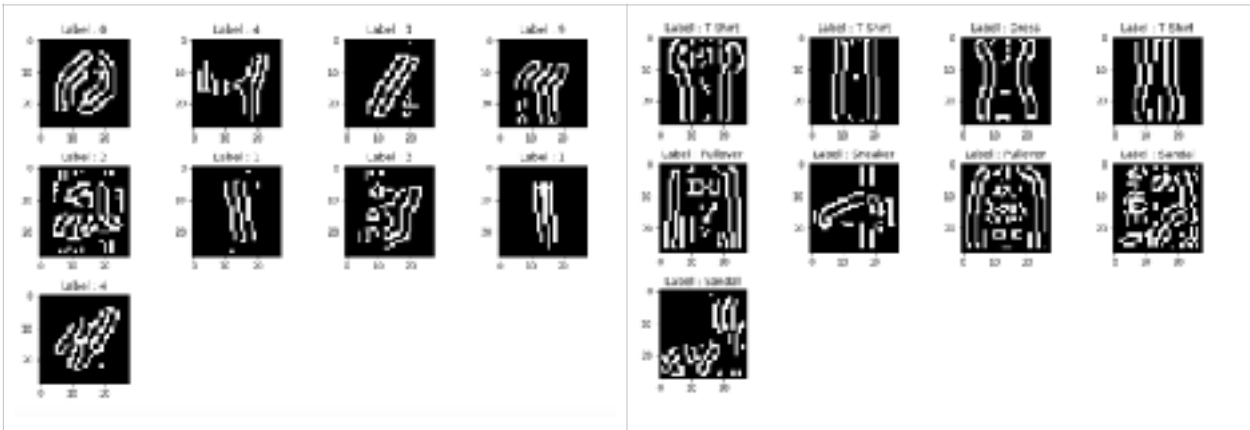
| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 16: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion followed by Fourier Transform and Canny Edge Detector.**



| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 17: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation followed by Principal Component Analysis and Canny Edge Detector.**

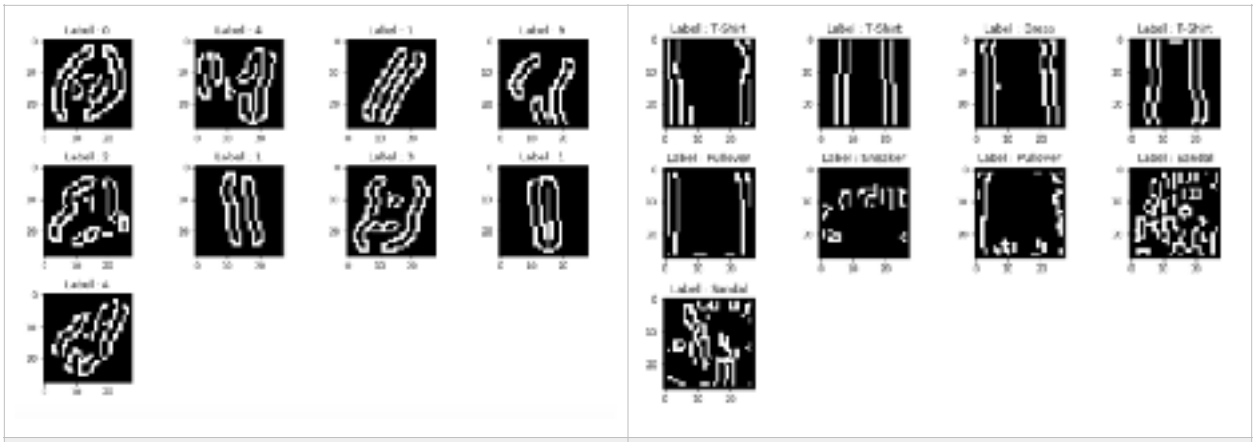


| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 18: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion followed by Principal Component Analysis and Canny Edge Detector.**

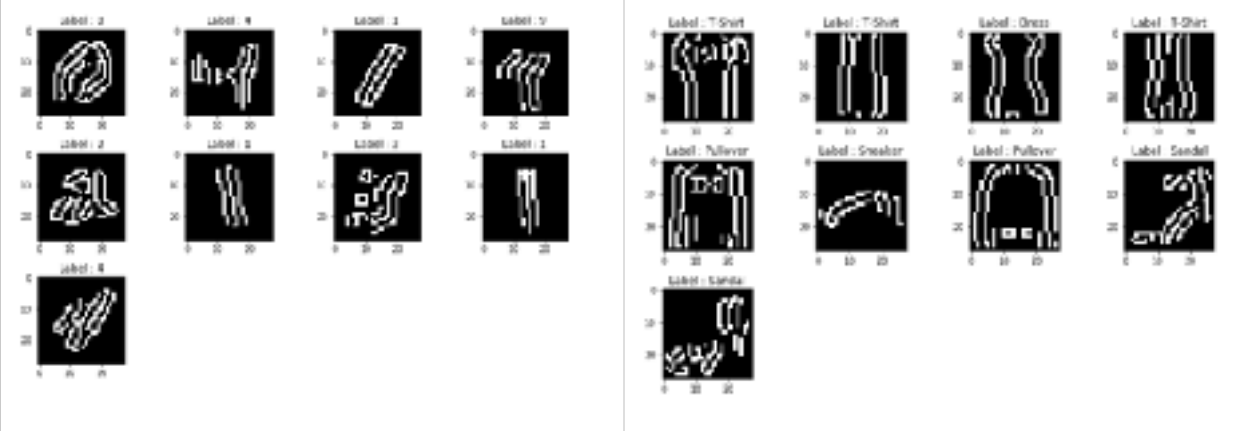
## LOCAL BINARY PATTERN

Local Binary Pattern (LBP) looks at points surrounding a central point and tests whether the surrounding points are greater than or less than the central point (i.e. gives a binary result). The Images below depicts the processed images after applying the LBP.



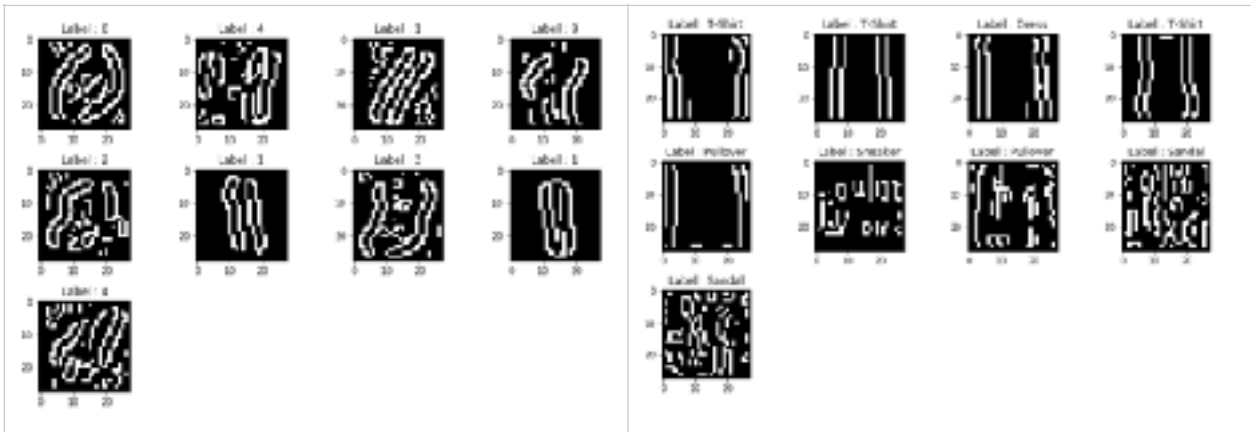
| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 19: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation followed by Fourier Transform and Local Binary Pattern**



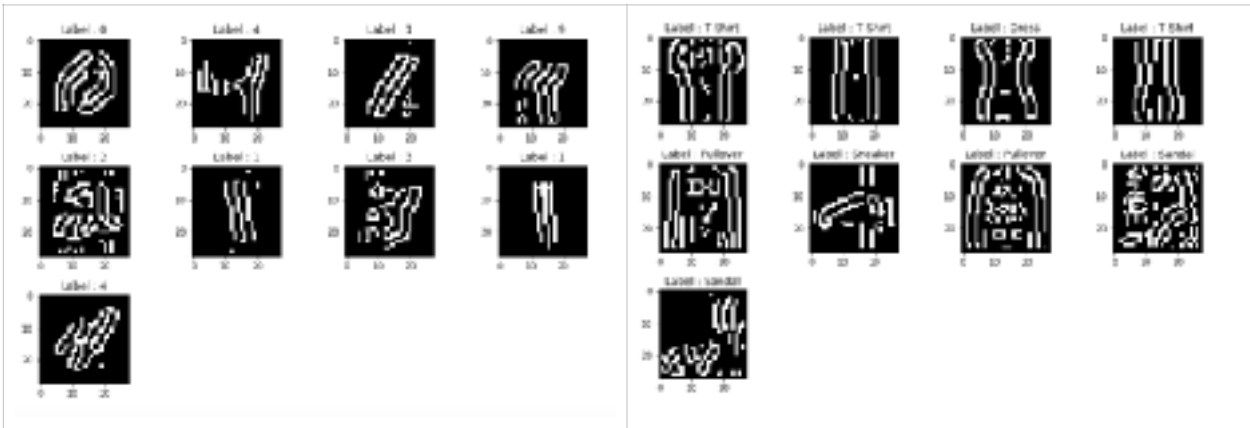
| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 20: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion followed by Fourier Transform and Local Binary Pattern**



| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 21: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation followed by Principal Component Analysis and Local Binary Pattern**

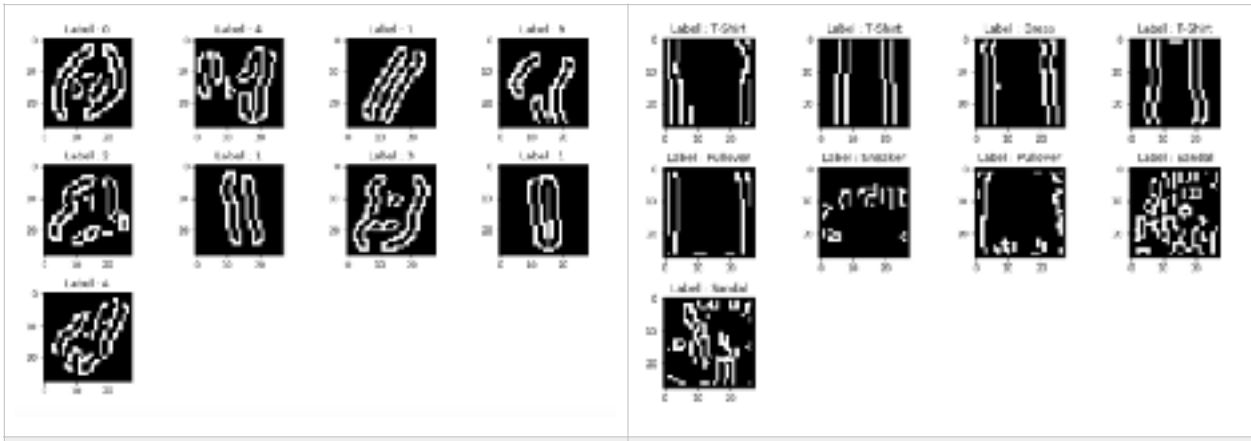


| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 22: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion followed by Principal Component Analysis and Local Binary Pattern**

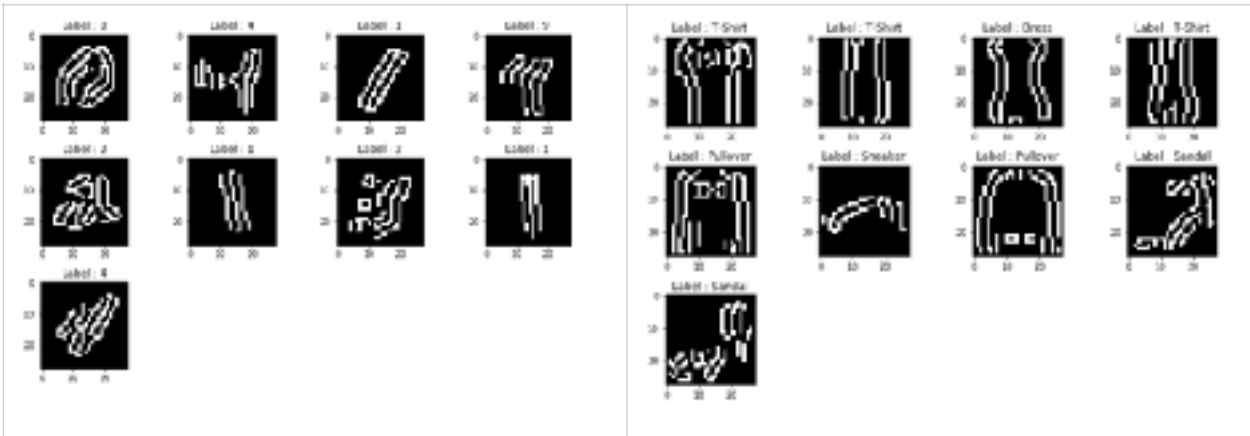
## PEAK LOCAL MAXIMA METHOD

Find peaks in an image as coordinate list or boolean mask.



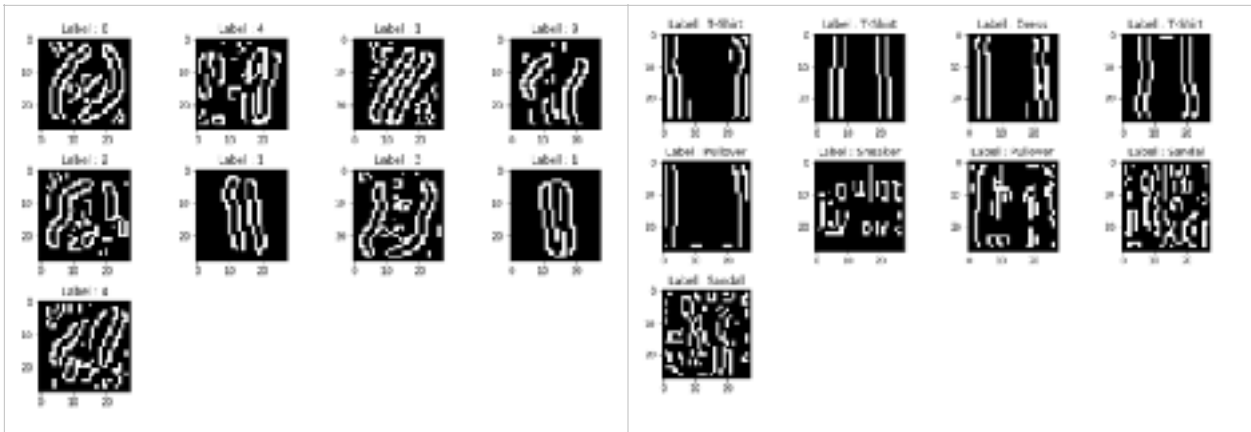
| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 23: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation followed by Fourier Transform and Peak Local Maxima**



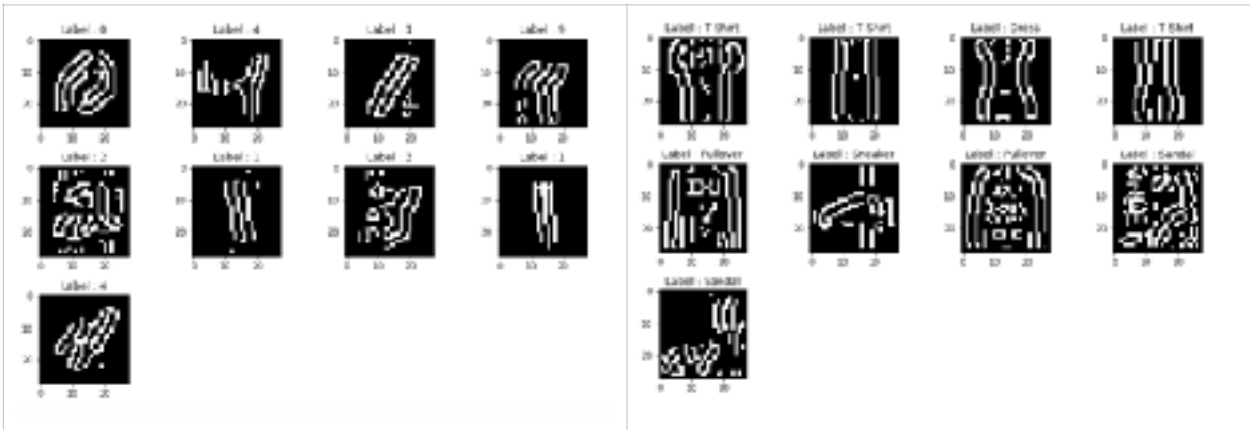
| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 24: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion followed by Fourier Transform and Peak Local Maxima**



| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 25: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Dilation followed by Principal Component Analysis and Peak Local Maxima**



| MNIST Dataset | Fashion MNIST Dataset |
|---|---|

**Figure 26: Sample images of MNIST(left) AND Fashion MNIST(right) dataset after applying Erosion followed by Principal Component Analysis and Peak Local Maxima**

## METHOD OF CLASSIFICATION

### MULTI-LAYER PERCEPTRON

It is a class of Feed-forward network. It consists of at least three Hidden layers of nodes. Each node is a neuron that uses a non-linear activation function. The figure given below shows the Architecture of the Multi-Layer perceptron used for this project.


**Figure 27: Multi-layer Perceptron Model**

## CONVOLUTIONAL NEURAL NETWORK

It is a class of deep, feed-forward network. They require relatively less pre-processing compared to other image classification algorithms. The figure given below shows the Architecture of the Convolution neural network used for this project.

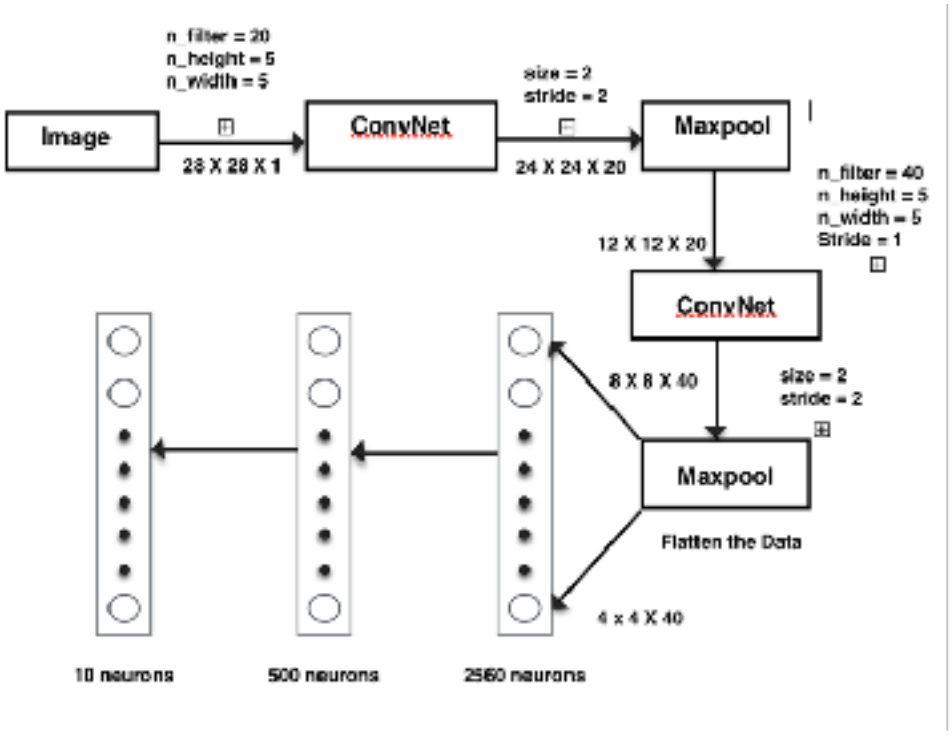



**Figure 28: Convolutional Neural network model**

At Each layer except the output Layer, I have used ReLu(Rectified Linear Unit) as the Non-

linear Activation Function. Softmax is applied at the output layer and Cross Entropy Loss is used to calculate the loss at each epoch.

**ReLu Function:**
f(x) = max(0, x)
**Softmax Function:**

$$P(y = j \mid \mathbf{x}) = \frac{e^{\mathbf{x}^\mathsf{T}\mathbf{w}_j}}{\sum_{k=1}^{K} e^{\mathbf{x}^\mathsf{T}\mathbf{w}_k}}$$

**Cross Entropy Loss Function:**
Loss = -(y * log(p) + (1 - y) * log(1 - p))

## RESULTS AND DISCUSSION

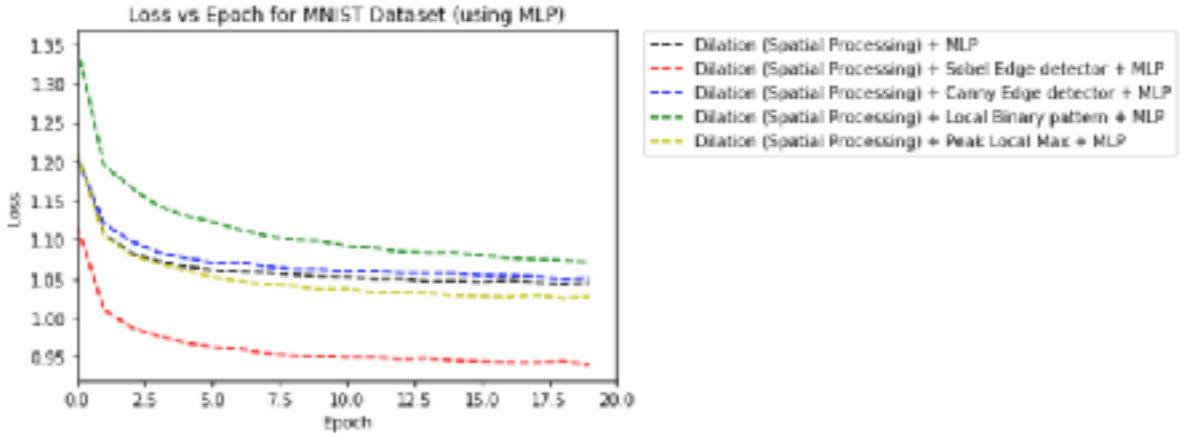



**Figure 29 : The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Dilation and Feature Extraction with MLP as Classifier**

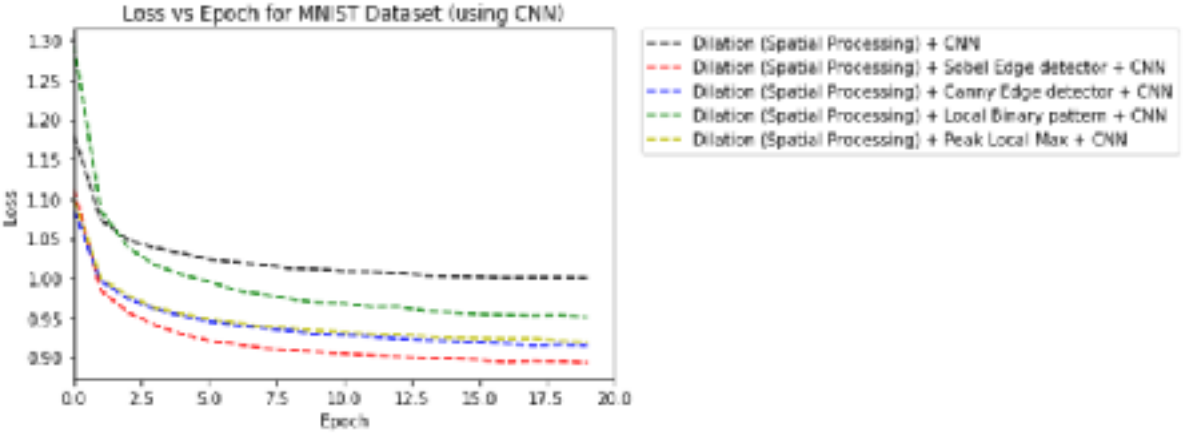



**Figure 30 : The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Dilation and Feature Extraction with CNN as Classifier**

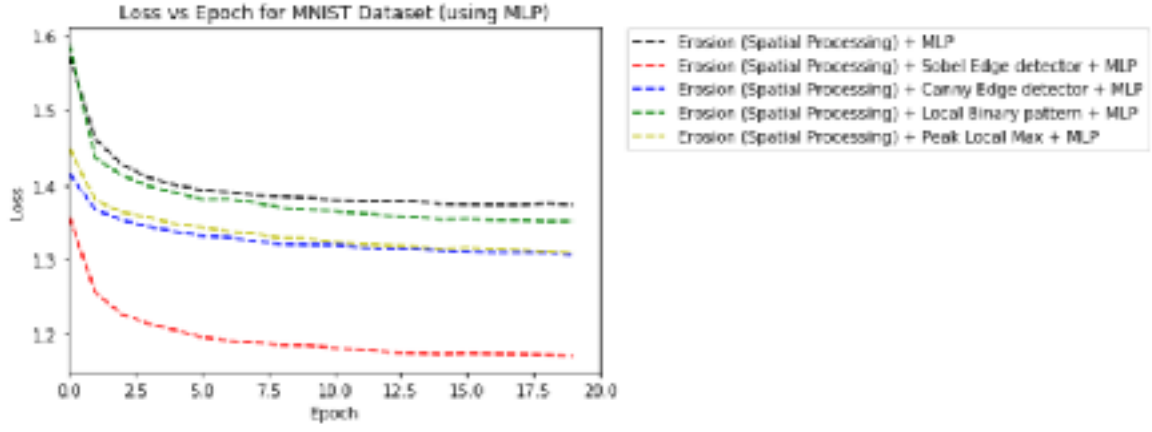


**Figure 31 : The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Erosion and Feature Extraction with MLP as Classifier**

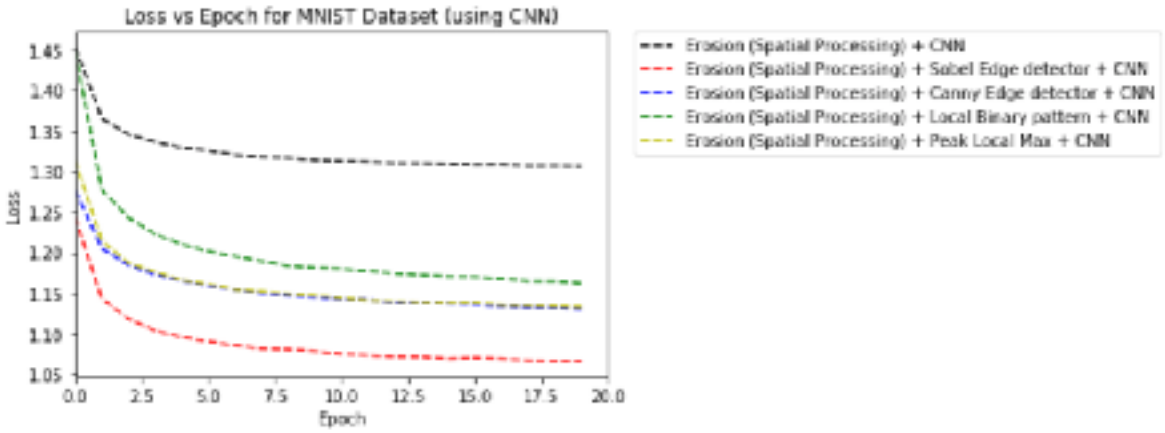



**Figure 32: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Erosion and Feature Extraction with CNN as Classifier**

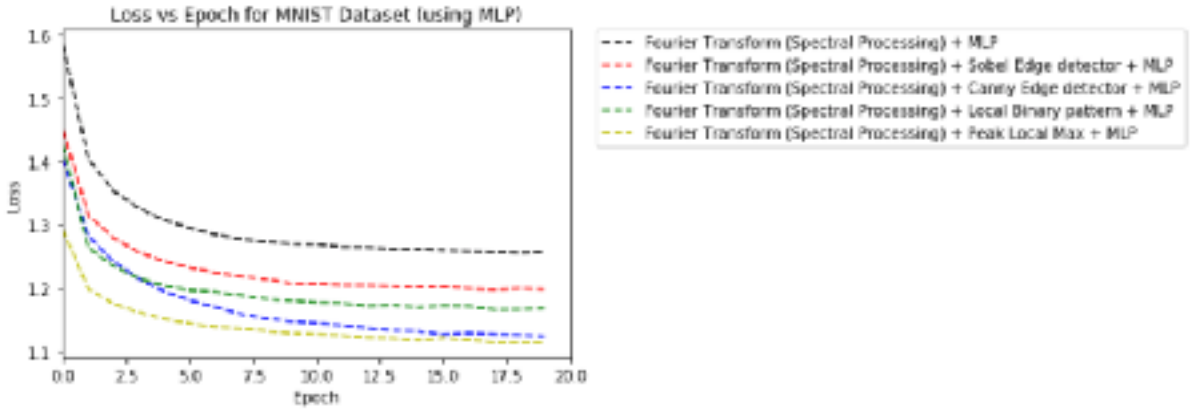



**Figure 33: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Fourier transform and Feature Extraction with MLP as Classifier**

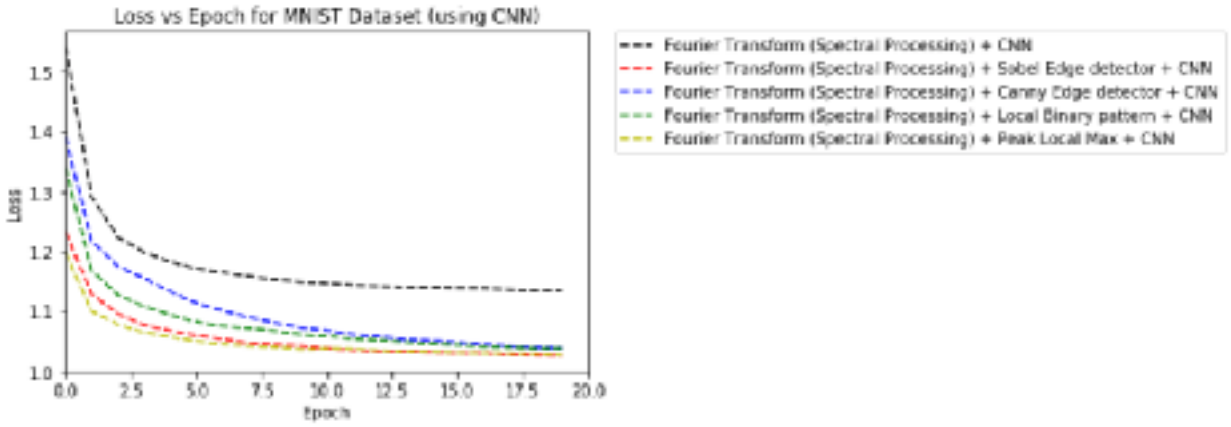



**Figure 34: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Fourier transform and Feature Extraction with CNN as Classifier**

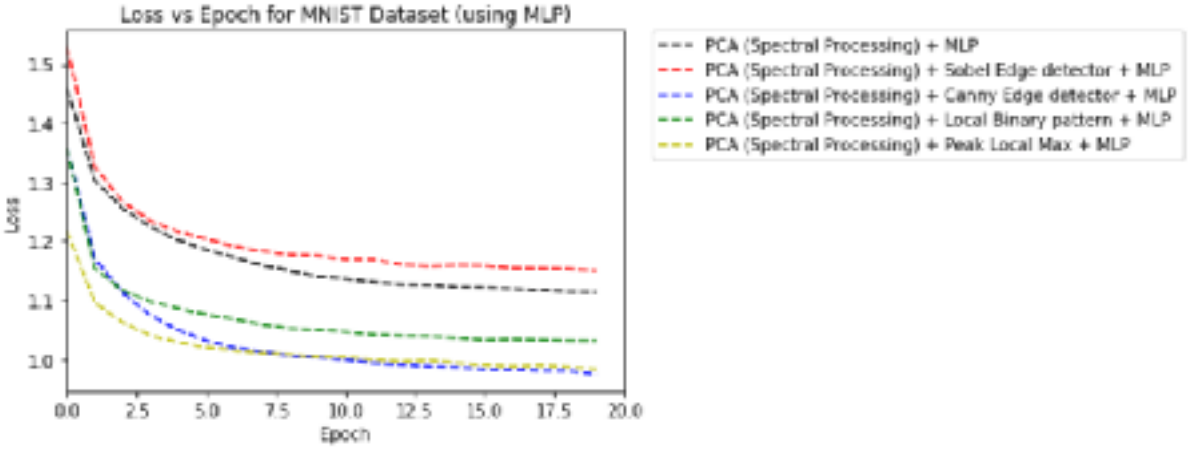



**Figure 35: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying PCA and Feature Extraction with MLP as Classifier**

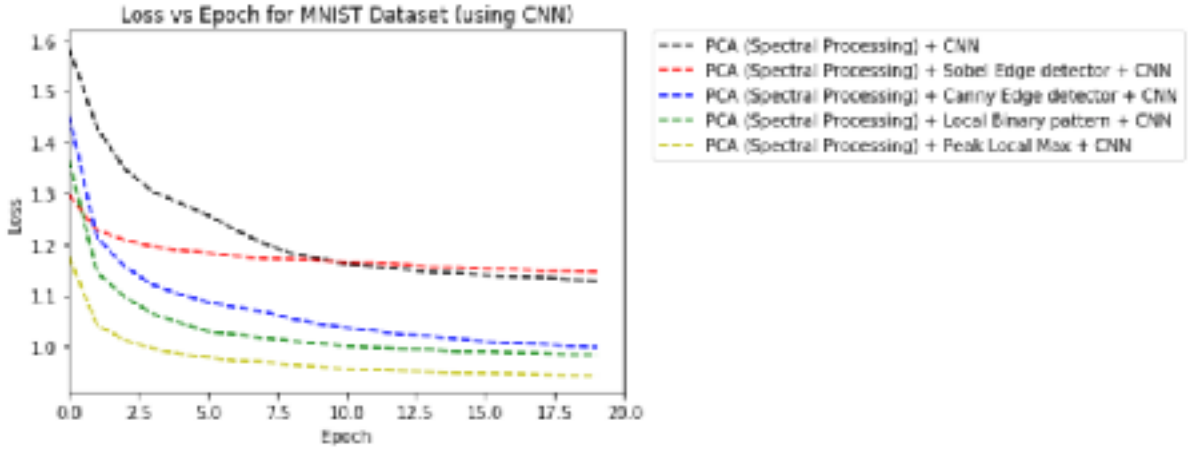


**Figure 36: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying PCA and Feature Extraction with CNN as Classifier**

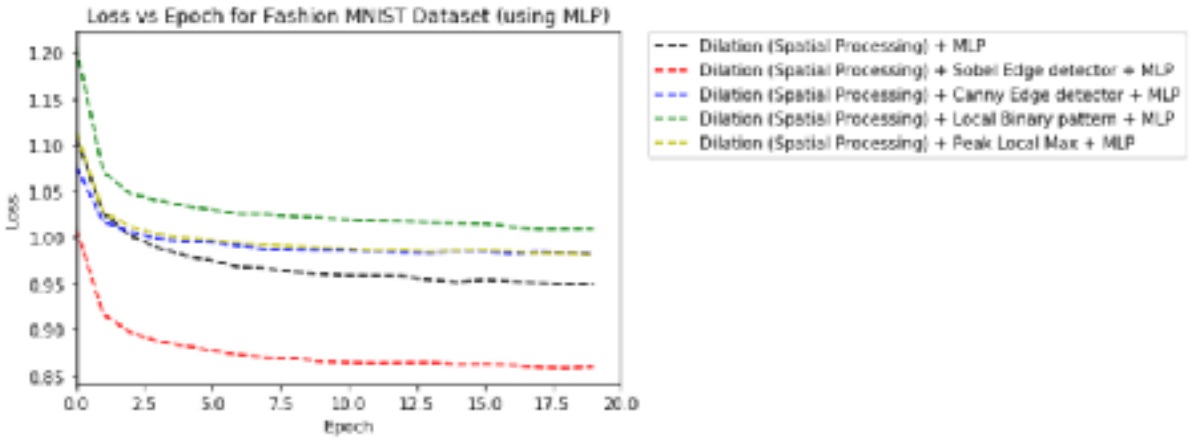



**Figure 37 : The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Dilation and Feature Extraction with MLP as Classifier**

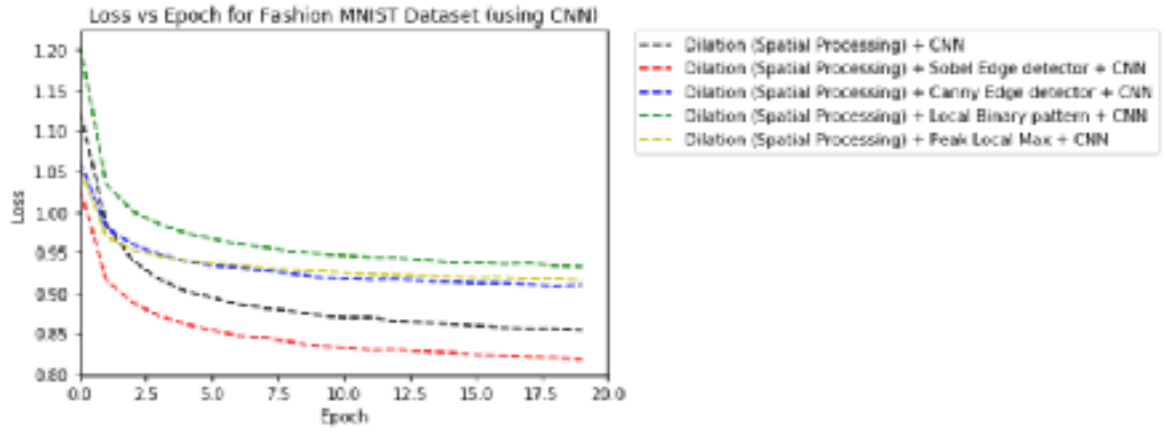



**Figure 38 : The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Dilation and Feature Extraction with CNN as Classifier**

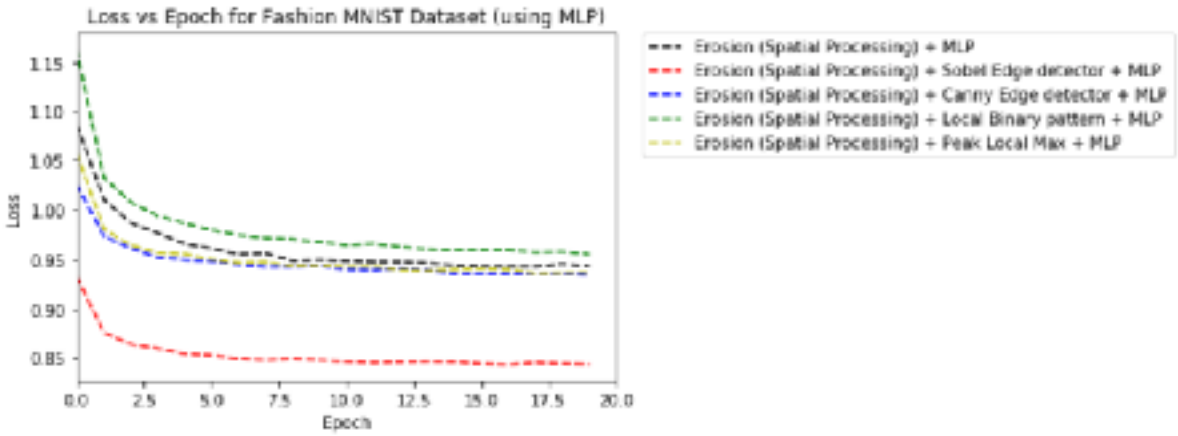


**Figure 39 : The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Erosion and Feature Extraction with MLP as Classifier**

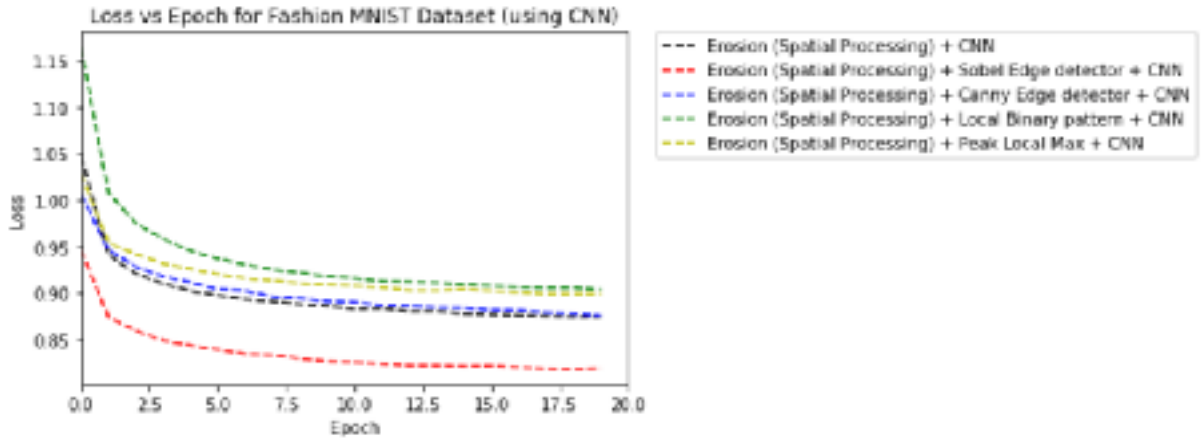



**Figure 40 : The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Erosion and Feature Extraction with CNN as Classifier**

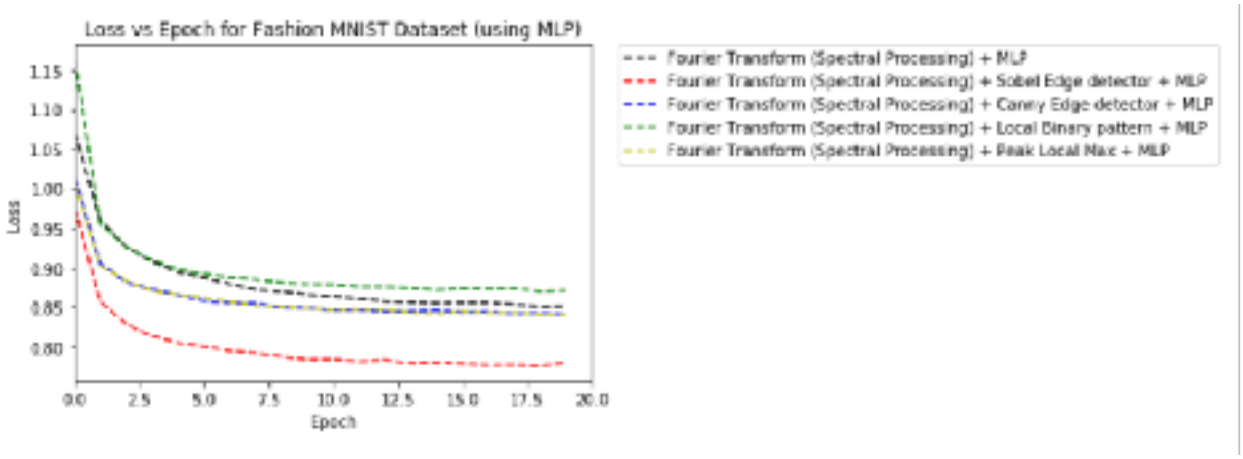



**Figure 41: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Fourier transform and Feature Extraction with MLP as Classifier**

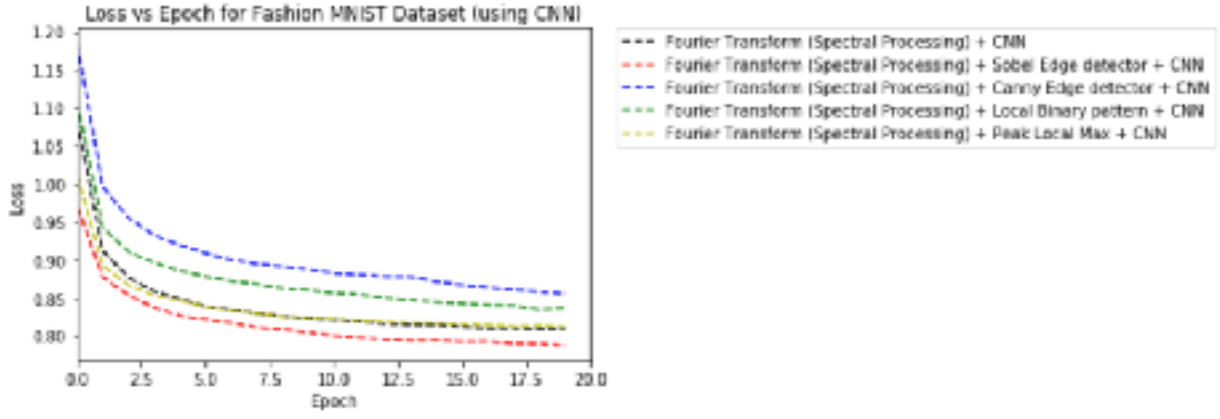


**Figure 42: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Fourier transform and Feature Extraction with CNN as Classifier**

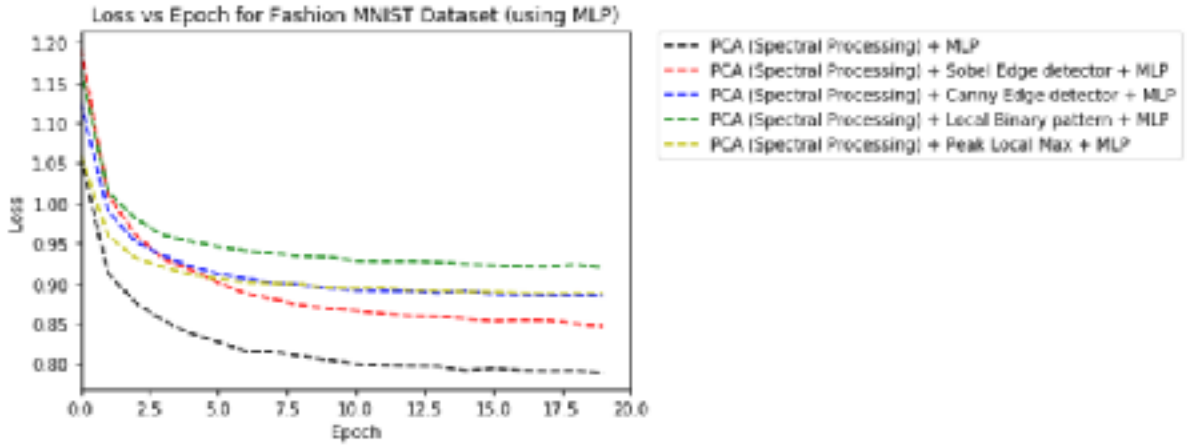



**Figure 43: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying PCA and Feature Extraction with MLP as Classifier**

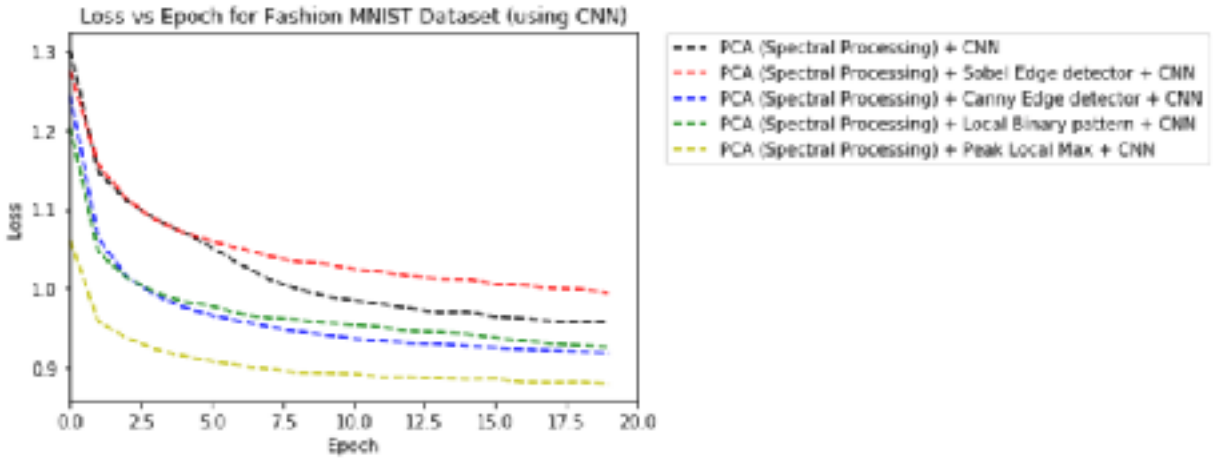



**Figure 44: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying PCA and Feature Extraction with CNN as Classifier**

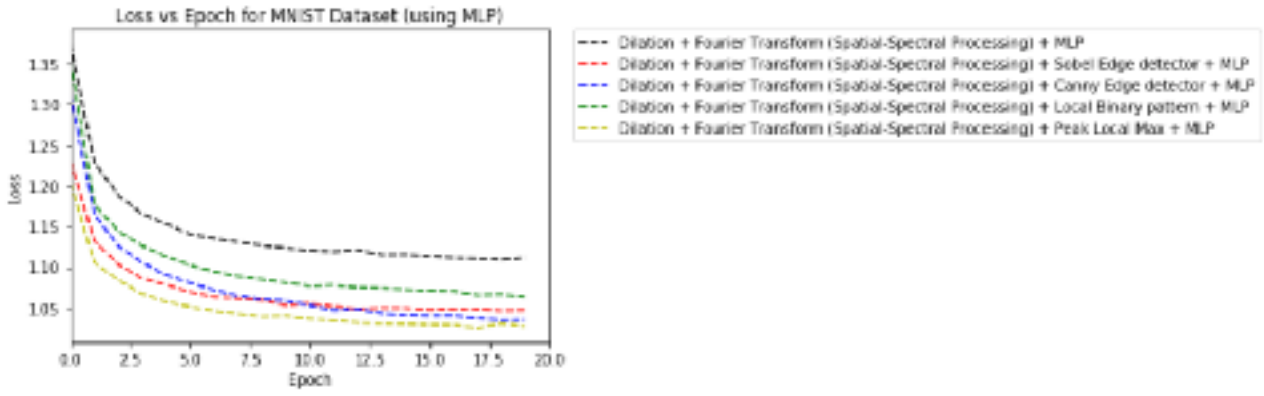



**Figure 45: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Dilation followed by Fourier Transform and Feature Extraction with MLP as Classifier**

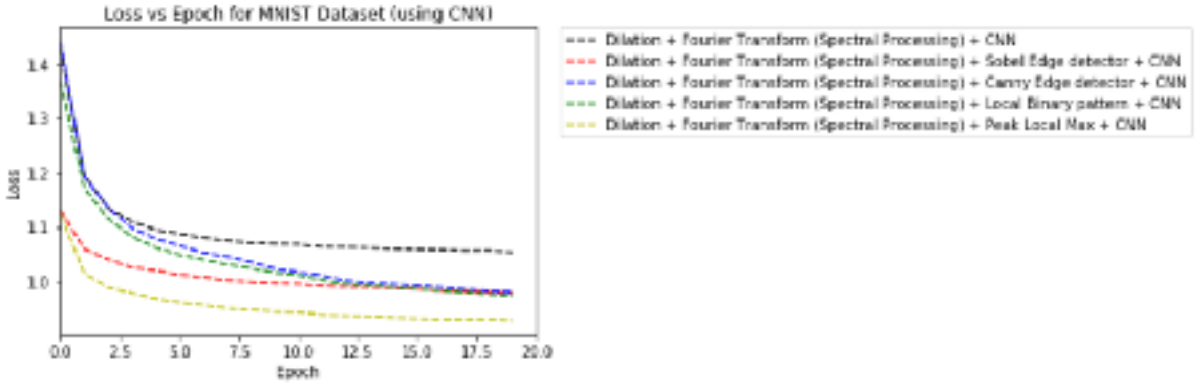



**Figure 46: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Dilation followed by Fourier Transform and Feature Extraction with CNN as Classifier**

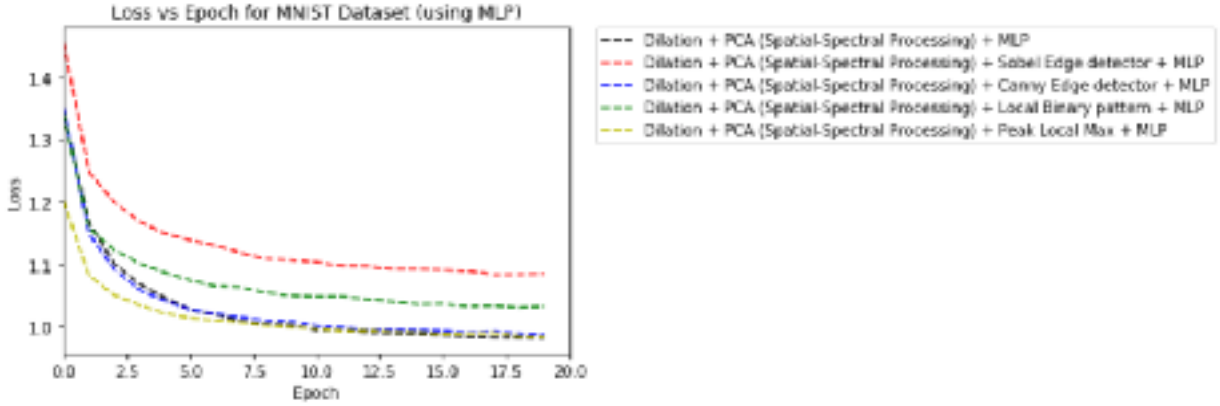


**Figure 47: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Dilation followed by PCA and Feature Extraction with MLP as Classifier**

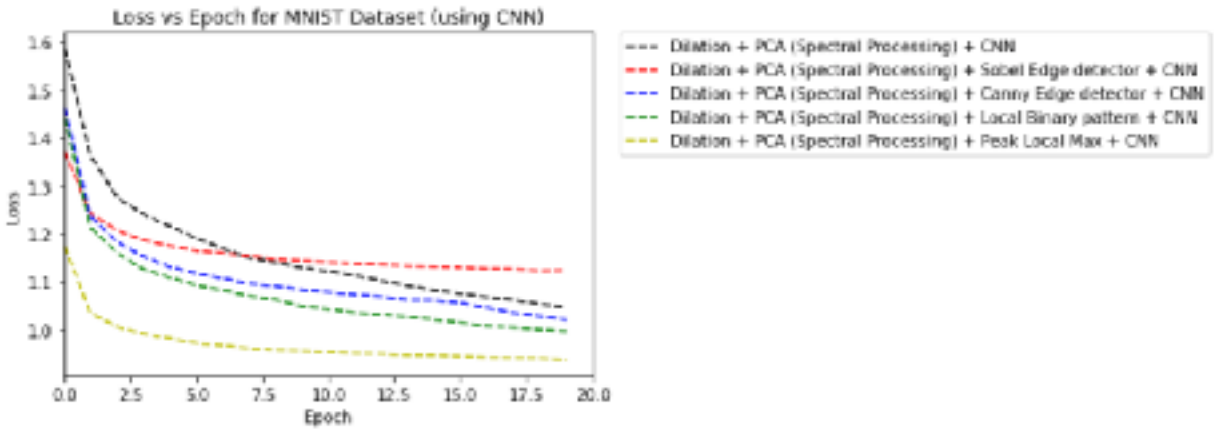



**Figure 48: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Dilation followed by PCA and Feature Extraction with CNN as Classifier**

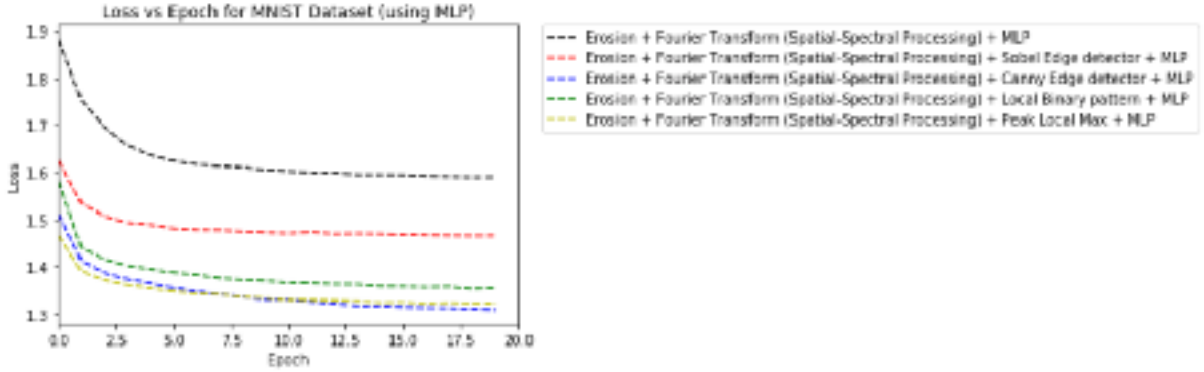



**Figure 49: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Erosion followed by Fourier Transform and Feature Extraction with MLP as Classifier**

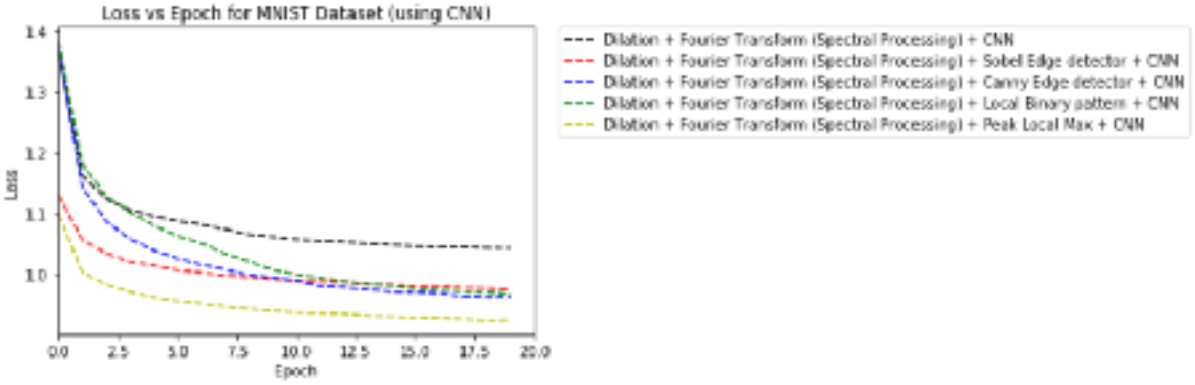


**Figure 50: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Erosion followed by Fourier Transform and Feature Extraction with CNN as Classifier**

Note : Forgot to change Legend values and noticed it very late to run the entire code again

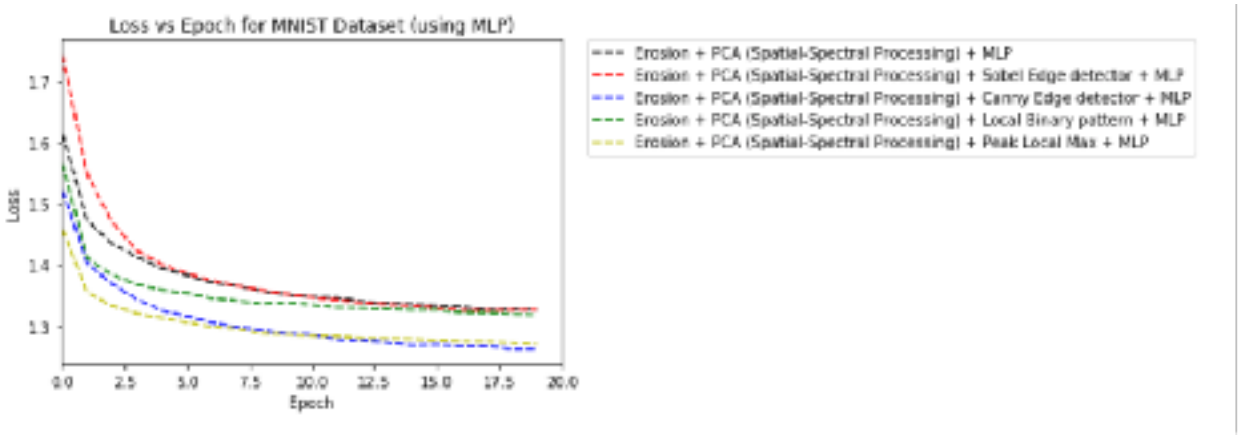



**Figure 51: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Erosion followed by PCA and Feature Extraction with MLP as Classifier**

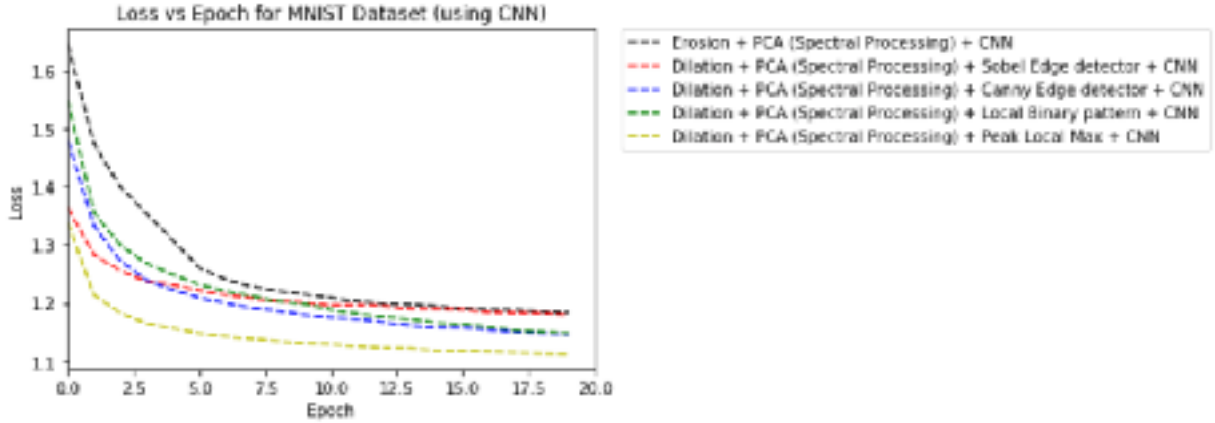



**Figure 52: The Image above shows the Loss versus Epoch graph for MNIST dataset after applying Erosion followed by PCA and Feature Extraction with MLP as Classifier**

Note : Forgot to change Legend values and noticed it very late to run the entire code again

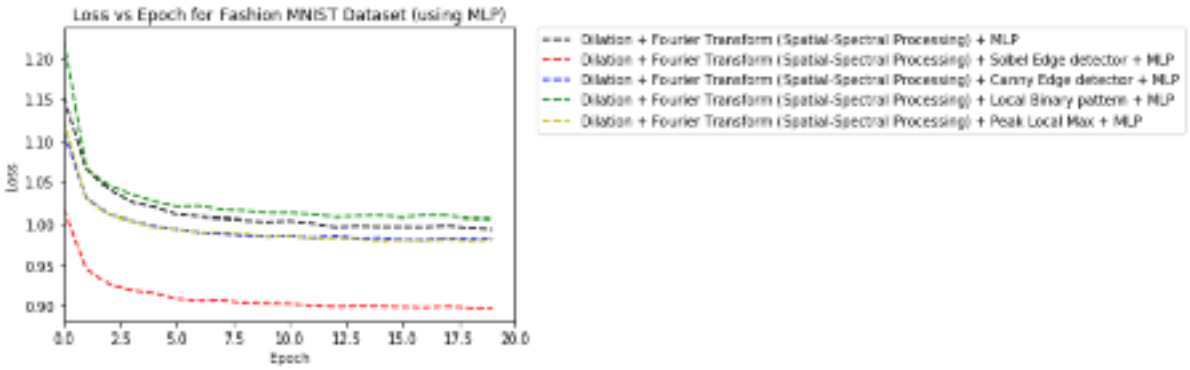



**Figure 53: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Dilation followed by Fourier Transform and Feature Extraction with MLP as Classifier**

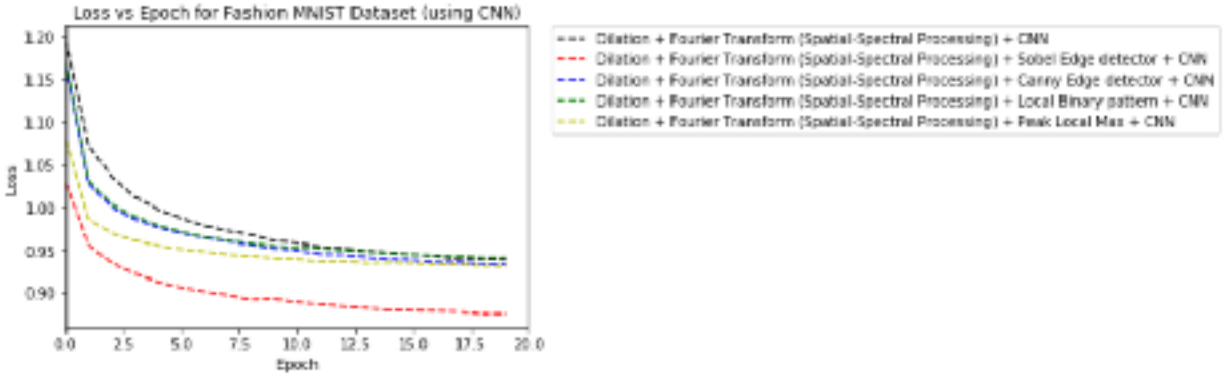



**Figure 54: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Dilation followed by Fourier Transform and Feature Extraction with CNN as Classifier**

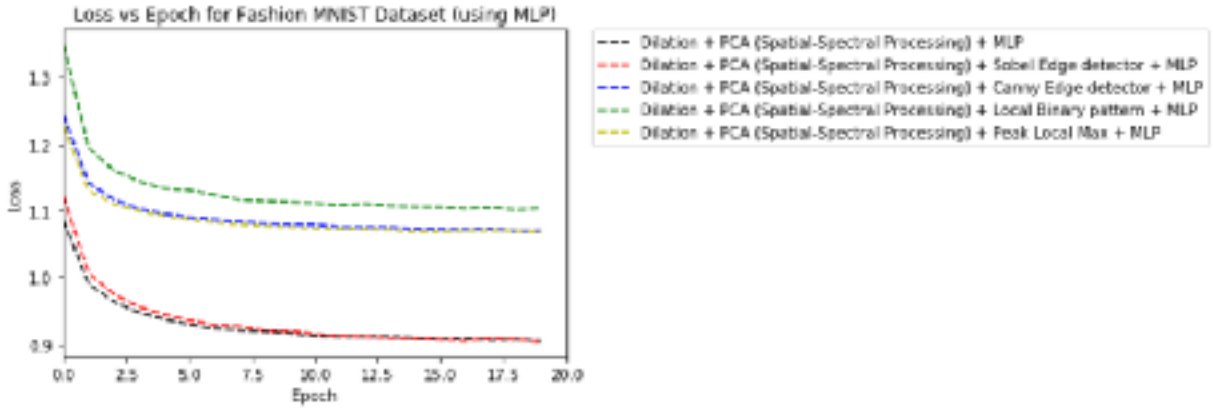


**Figure 55: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Dilation followed by PCA and Feature Extraction with MLP as Classifier**

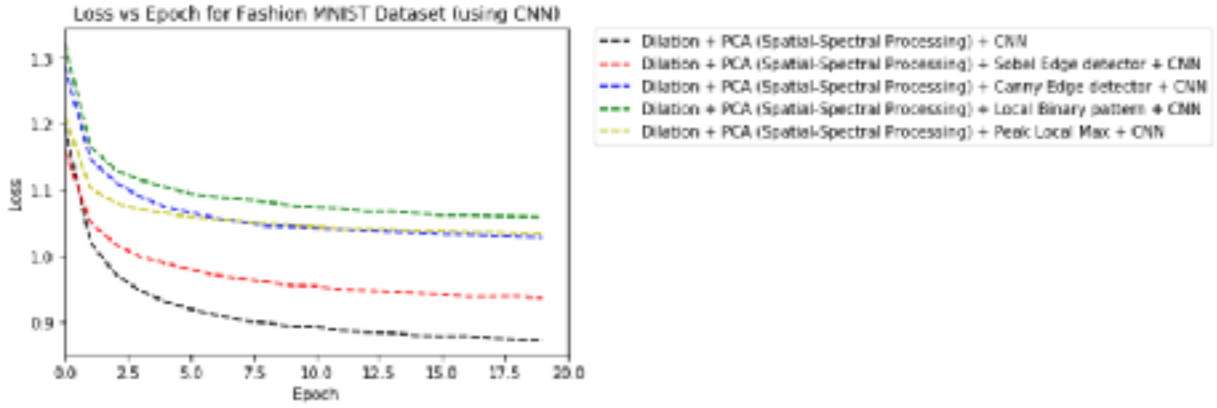



**Figure 56: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Dilation followed by PCA and Feature Extraction with CNN as Classifier**

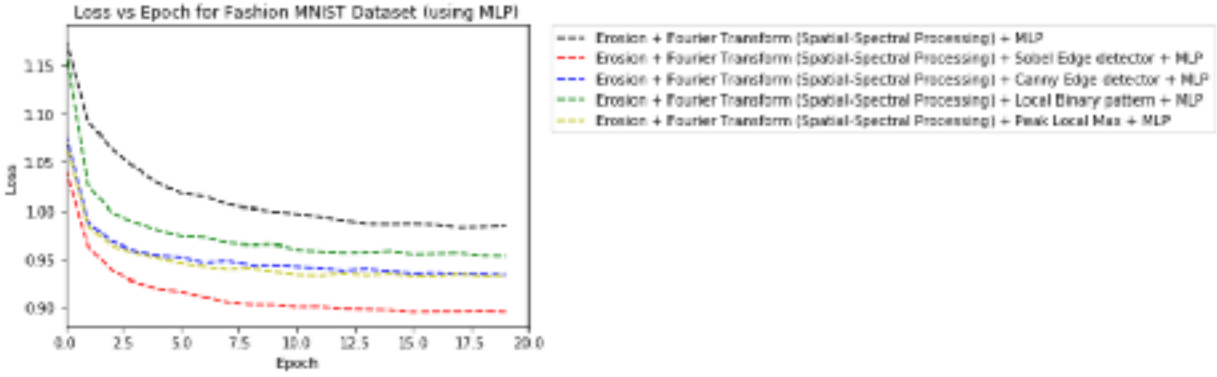



**Figure 57: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Erosion followed by Fourier Transform and Feature Extraction with MLP as Classifier**

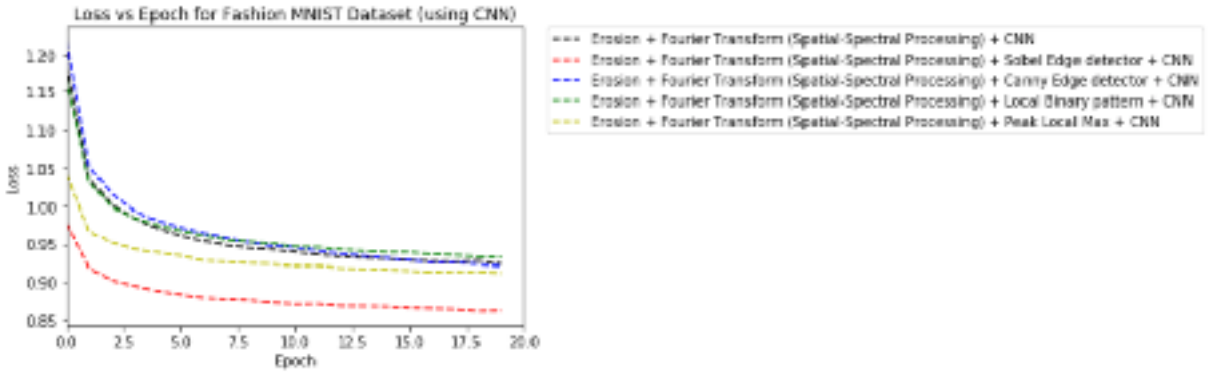



**Figure 58: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Erosion followed by Fourier Transform and Feature Extraction with CNN as Classifier**

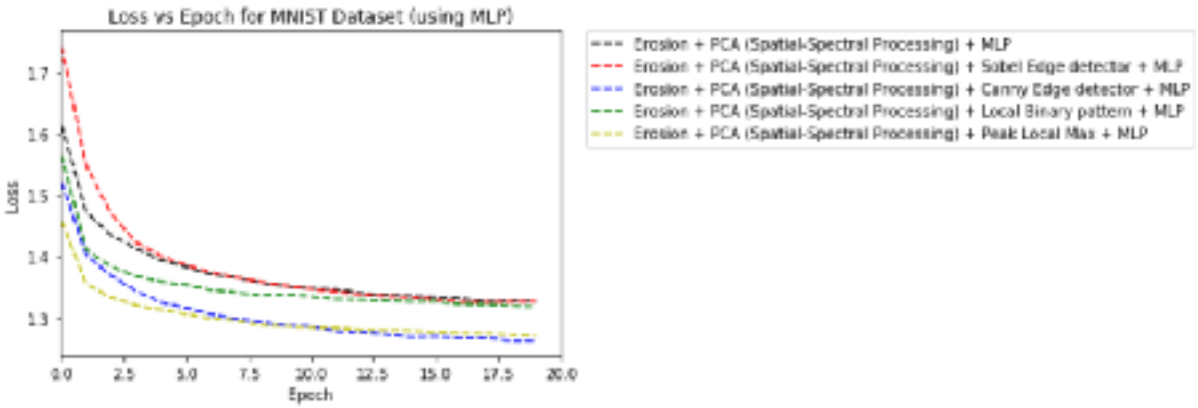



**Figure 59: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Erosion followed byPCA and Feature Extraction with MLP as Classifier**

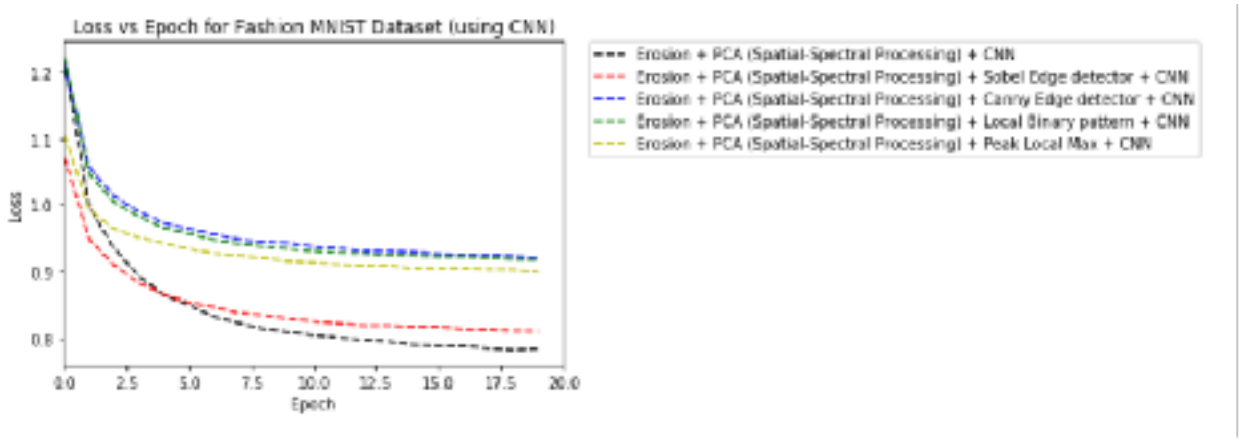



**Figure 60: The Image above shows the Loss versus Epoch graph for Fashion MNIST dataset after applying Erosion followed byPCA and Feature Extraction with CNN as Classifier**

| | MLP | CNN |
|---|---|---|
| Dilation | 62 | 64 |
| Erosion | 49 | 52 |
| Fourier transform | 54 | 59 |
| PCA | 58 | 58 |
| Dilation+Fourier | 57 | 62 |
| Dilation+PCA | 64 | 52 |
| Erosion+Fourier | 37 | 62 |
| Erosion+PCA | 51 | 57 |

**Table 1 : Accuracy of MNIST data using different processing methods and no Feature Extraction Technique**

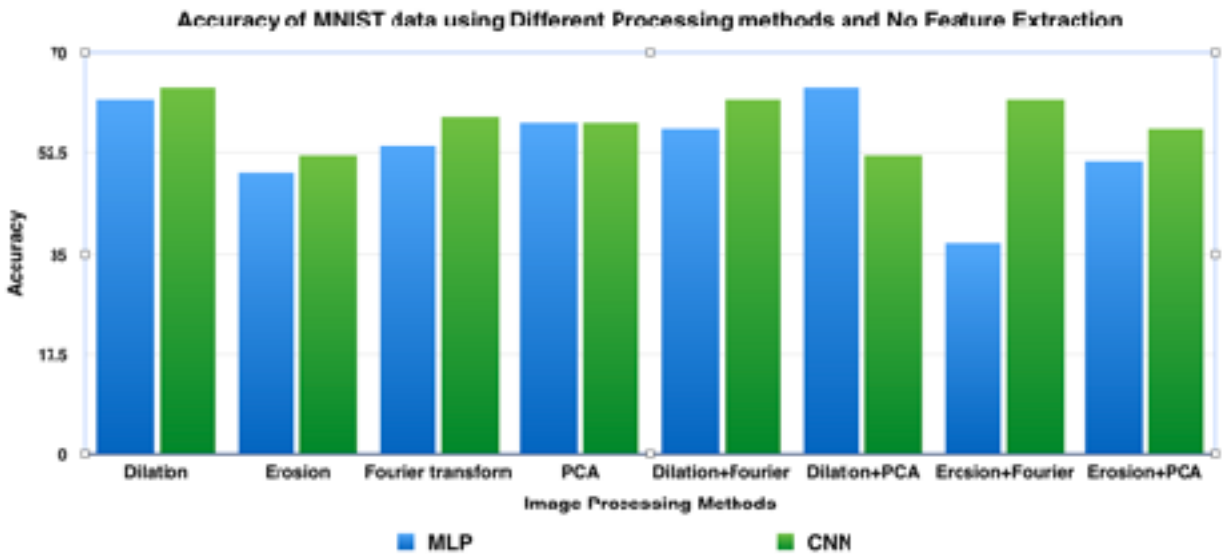



**Figure 61 : Accuracy of MNIST data using different processing methods and no Feature Extraction Technique**

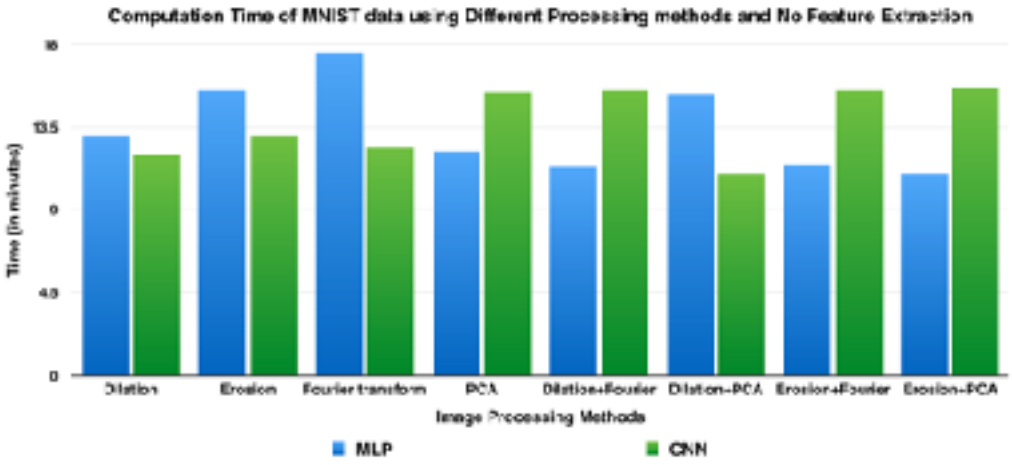



**Figure 62 : Computation time of MNIST data using different processing methods and no Feature Extraction Technique**

| | MLP | CNN |
|---|---|---|
| Dilation | 67 | 67 |
| Erosion | 60 | 62 |
| Fourier transform | 51 | 62 |
| PCA | 55 | 57 |
| Dilation+Fourier | 59 | 62 |
| Dilation+PCA | 58 | 58 |
| Erosion+Fourier | 44 | 64 |
| Erosion+PCA | 49 | 57 |

**Table 2 : Accuracy of MNIST data using different processing methods and Sobel Edge Detector for Feature Extraction**

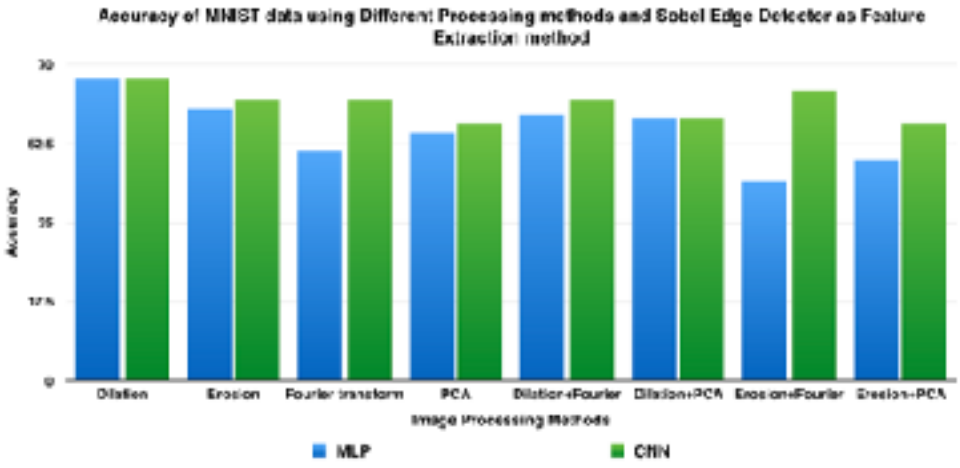



**Figure 63 : Accuracy of MNIST data using different processing methods and Sobel Edge Detector for Feature Extraction**

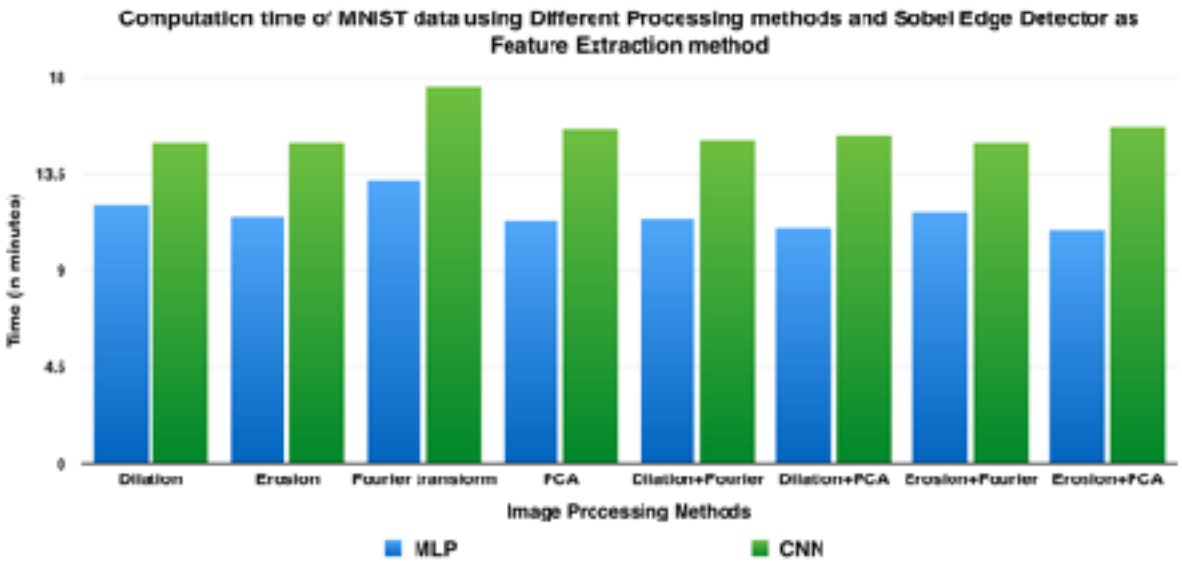



**Figure 64 : Computation time of MNIST data using different processing methods and Sobel Edge Detector for Feature Extraction**

| | MLP | CNN |
|---|---|---|
| Dilation | 64 | 65 |
| Erosion | 54 | 59 |
| Fourier transform | 61 | 63 |
| PCA | 64 | 64 |
| Dilation+Fourier | 62 | 65 |
| Dilation+PCA | 65 | 64 |
| Erosion+Fourier | 54 | 66 |
| Erosion+PCA | 58 | 55 |

**Table 3 : Accuracy of MNIST data using different processing methods and Canny Edge Detector for Feature Extraction**

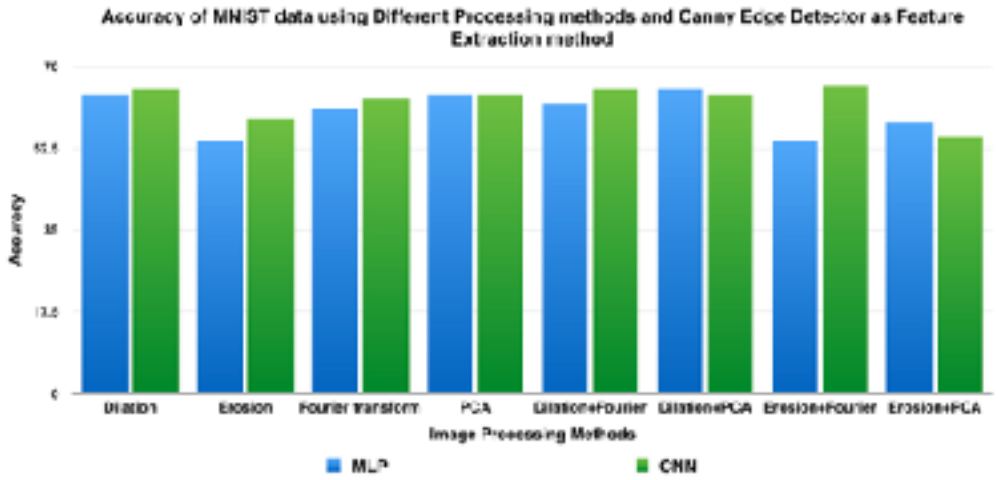



**Figure 65 : Accuracy of MNIST data using different processing methods and Canny Edge Detector for Feature Extracti**

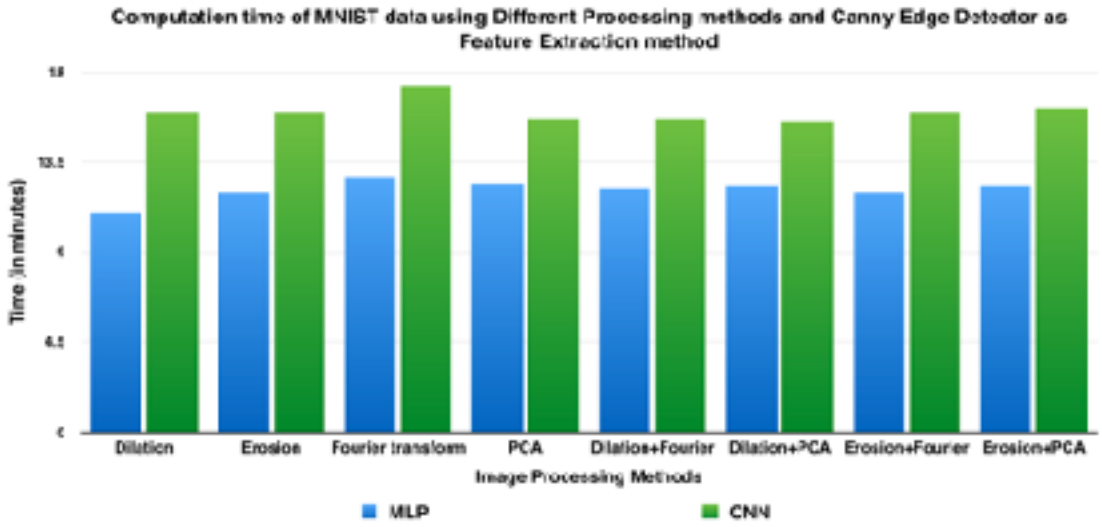


**Figure 66 : Computation time of MNIST data using different processing methods and Canny Edge Detector for Feature Extraction**

| | MLP | CNN |
|---|---|---|
| Dilation | 62 | 65 |
| Erosion | 52 | 58 |
| Fourier transform | 58 | 62 |
| PCA | 64 | 65 |
| Dilation+Fourier | 61 | 64 |
| Dilation+PCA | 65 | 64 |
| Erosion+Fourier | 50 | 65 |
| Erosion+PCA | 51 | 58 |

**Table 4 : Accuracy of MNIST data using different processing methods and Local binary pattern for Feature Extraction**

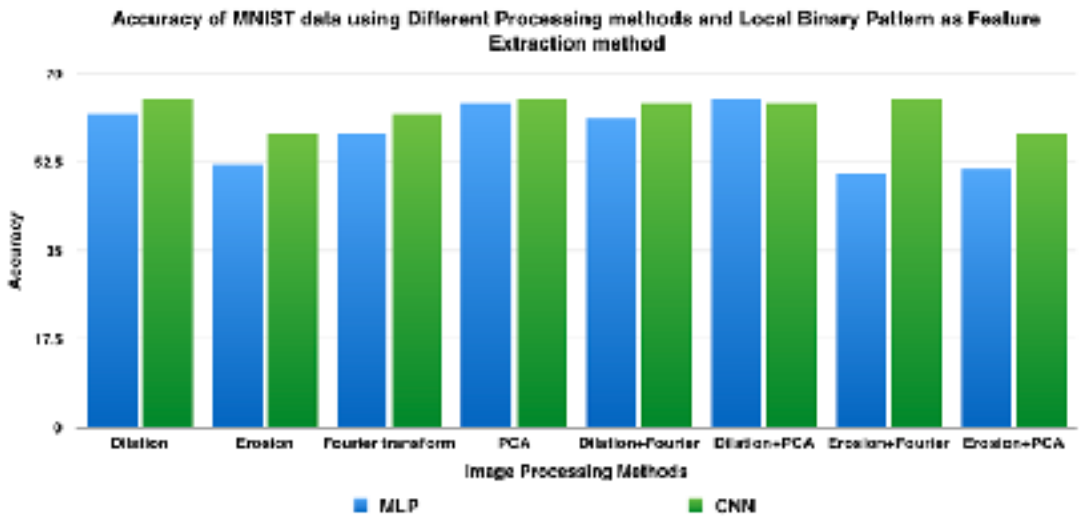



**Figure 67 : Accuracy of MNIST data using different processing methods and Local binary pattern for Feature Extraction**

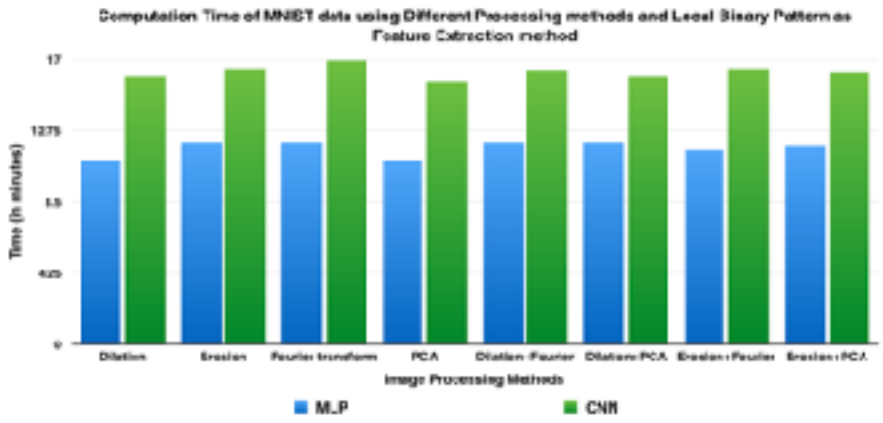



**Figure 68 : Computation time of MNIST data using different processing methods and Local binary pattern for Feature Extraction**

| | MLP | CNN |
|---|---|---|
| Dilation | 64 | 65 |
| Erosion | 54 | 58 |
| Fourier transform | 59 | 62 |
| PCA | 63 | 65 |
| Dilation+Fourier | 64 | 65 |
| Dilation+PCA | 66 | 65 |
| Erosion+Fourier | 53 | 67 |
| Erosion+PCA | 54 | 59 |

**Table 5 : Accuracy of MNIST data using different processing methods and Peak Local Maxima for Feature Extraction**

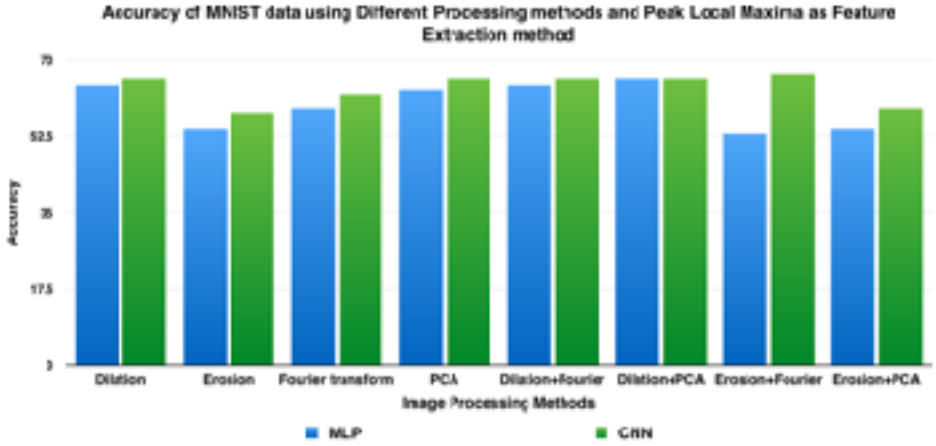


**Figure 69 : Accuracy of MNIST data using different processing methods and Peak Local Maxima for Feature Extraction**

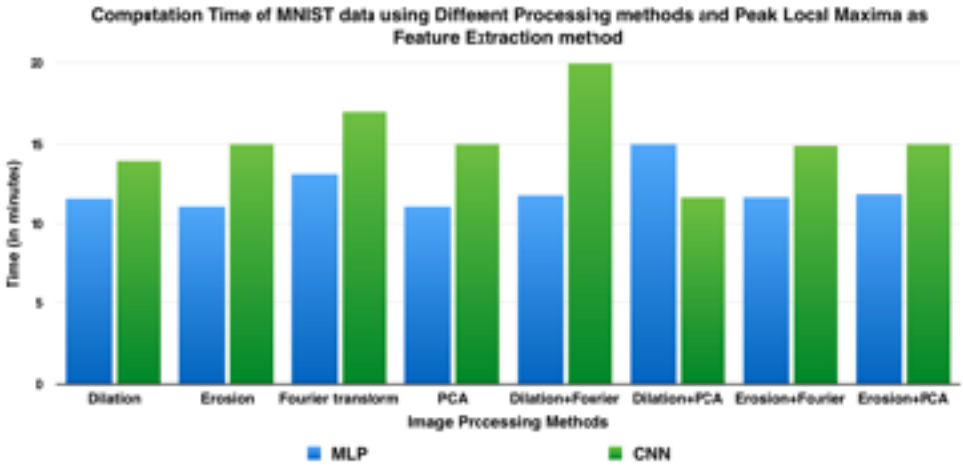



**Figure 70 : Computation time of MNIST data using different processing methods and Peak Local Maxima for Feature Extraction**

| | MLP | CNN |
|---|---|---|
| Dilation | 58 | 63 |
| Erosion | 59 | 62 |
| Fourier transform | 61 | 65 |
| PCA | 64 | 59 |
| Dilation+Fourier | 56 | 61 |
| Dilation+PCA | 60 | 64 |
| Erosion+Fourier | 37 | 62 |
| Erosion+PCA | 51 | 57 |

**Table 6 : Accuracy of Fashion MNIST data using different processing methods and No Feature Extraction**

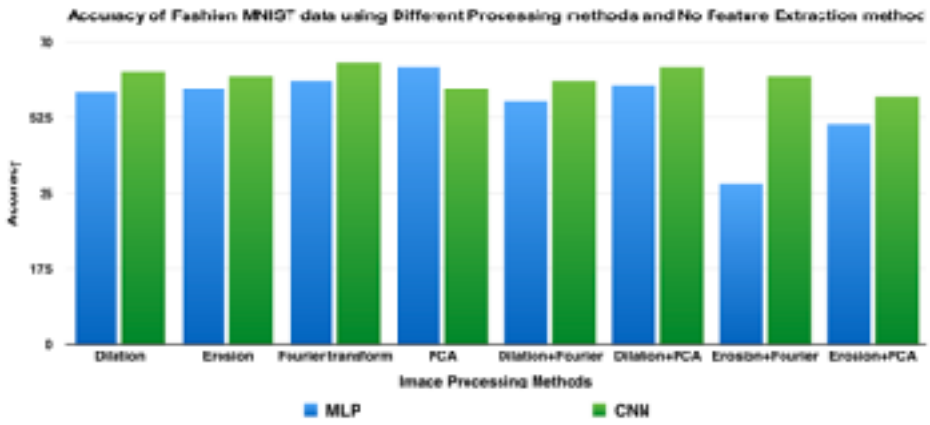


**Figure 71 : Accuracy of Fashion MNIST data using different processing methods and No Feature Extraction**

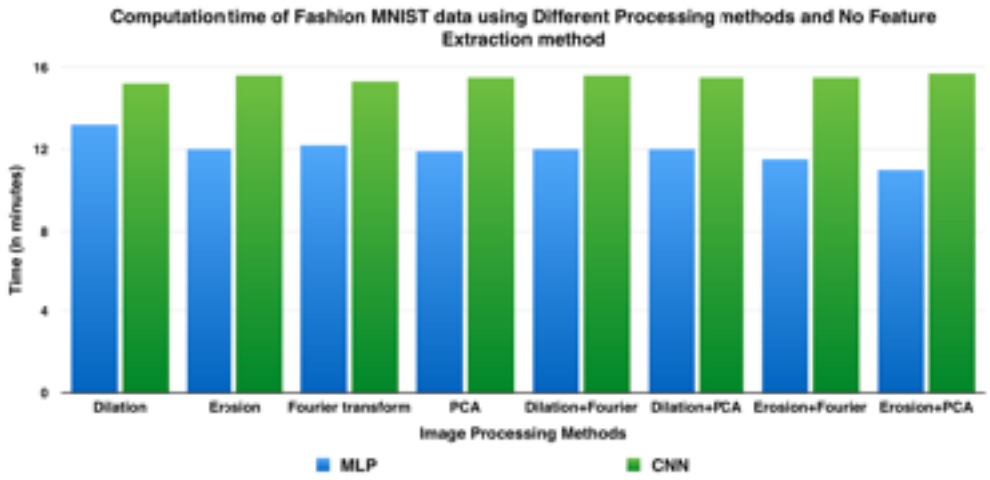



**Figure 72 : Computation time of Fashion MNIST data using different processing methods and No Feature Extraction**

| | MLP | CNN |
|---|---|---|
| Dilation | 64 | 64 |
| Erosion | 65 | 65 |
| Fourier transform | 64 | 66 |
| PCA | 62 | 61 |
| Dilation+Fourier | 61 | 62 |
| Dilation+PCA | 60 | 61 |
| Erosion+Fourier | 44 | 64 |
| Erosion+PCA | 49 | 57 |

**Table 7 : Accuracy of Fashion MNIST data using different processing methods and Sobel Edge detector for Feature Extraction**

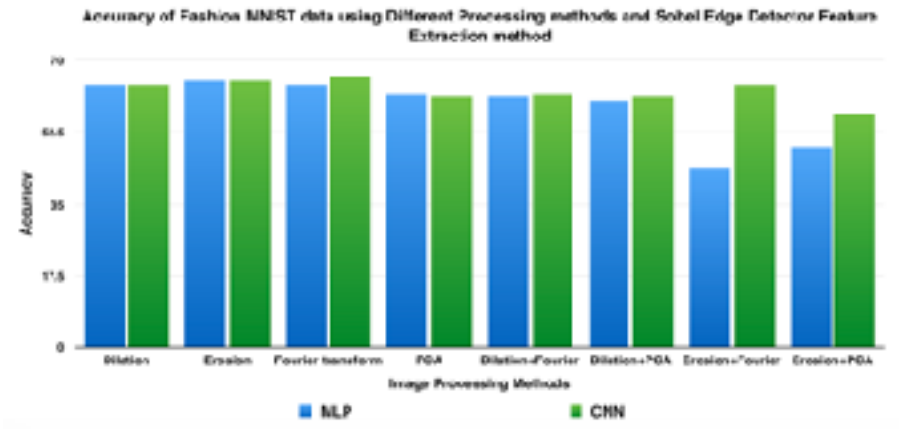



**Figure 73 : Accuracy of Fashion MNIST data using different processing methods and Sobel Edge detector for Feature Extraction**

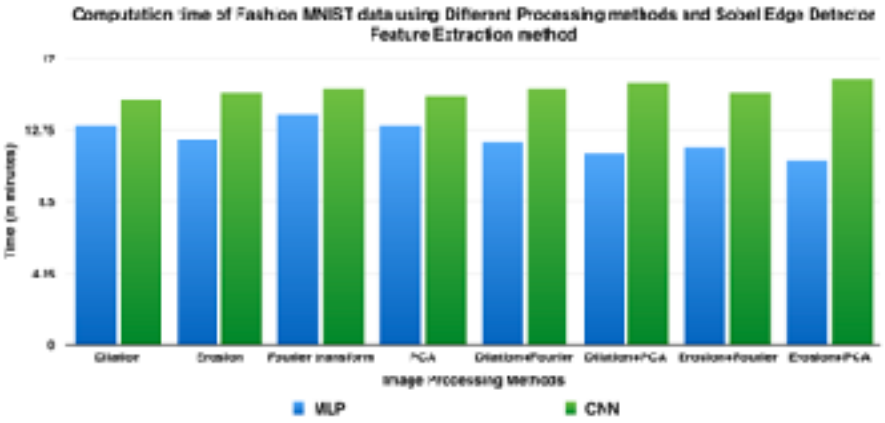



**Figure 74 : Computation time of Fashion MNIST data using different processing methods and Sobel Edge detector for Feature Extraction**

| | MLP | CNN |
|---|---|---|
| Dilation | 58 | 61 |
| Erosion | 61 | 62 |
| Fourier transform | 64 | 64 |
| PCA | 64 | 61 |
| Dilation+Fourier | 59 | 59 |
| Dilation+PCA | 58 | 55 |
| Erosion+Fourier | 54 | 66 |
| Erosion+PCA | 55 | 58 |

**Table 8 : Accuracy of Fashion MNIST data using different processing methods and Canny Edge detector for Feature Extraction**

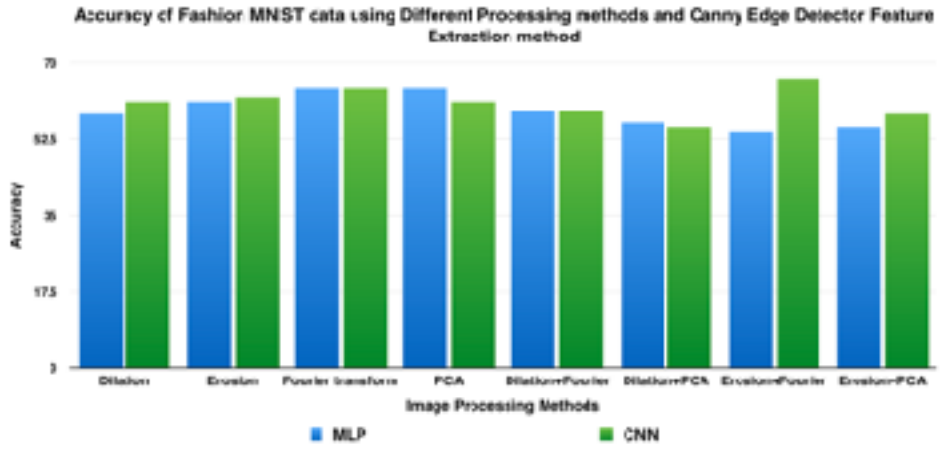



**Figure 75 : Accuracy of Fashion MNIST data using different processing methods and Canny Edge detector for Feature Extraction**

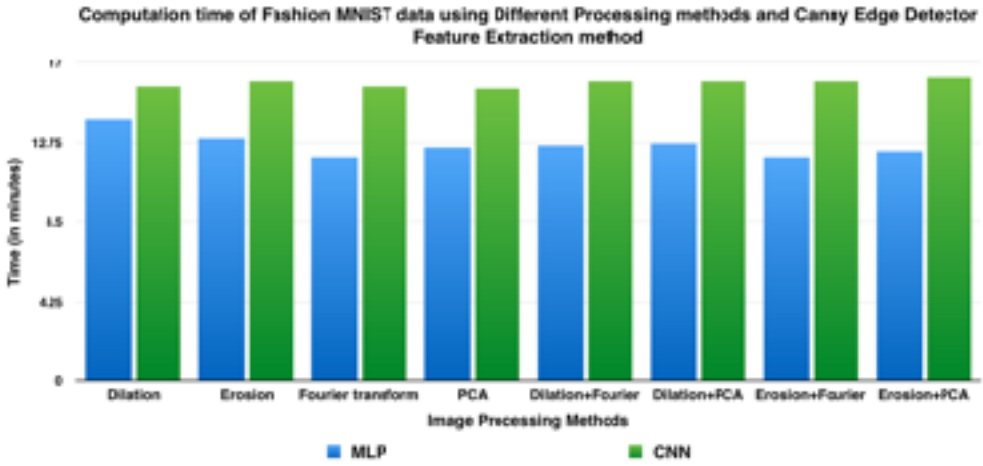



**Figure 76 : Computation time of Fashion MNIST data using different processing methods and Canny Edge detector for Feature Extraction**

| | MLP | CNN |
|---|---|---|
| Dilation | 58 | 59 |
| Erosion | 59 | 62 |
| Fourier transform | 63 | 64 |
| PCA | 62 | 62 |
| Dilation+Fourier | 57 | 60 |
| Dilation+PCA | 54 | 56 |
| Erosion+Fourier | 54 | 65 |
| Erosion+PCA | 51 | 58 |

**Table 8 : Accuracy of Fashion MNIST data using different processing methods and Local Binary Pattern for Feature Extraction**

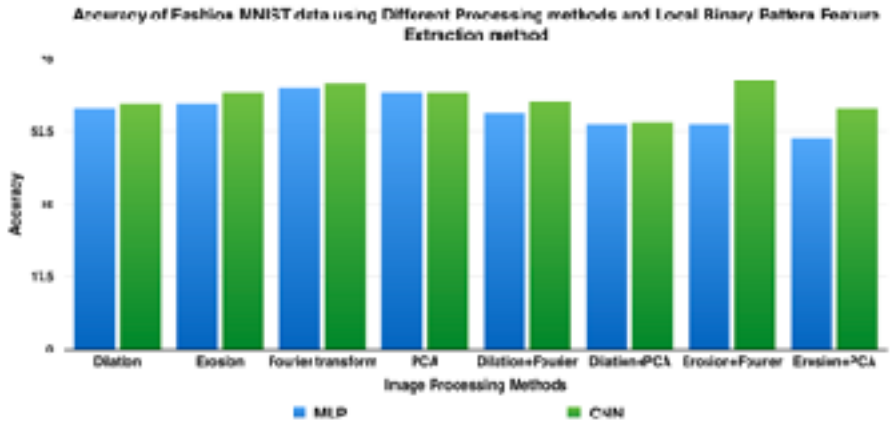



**Figure 77 : Accuracy of Fashion MNIST data using different processing methods and Local Binary Pattern for Feature Extraction**

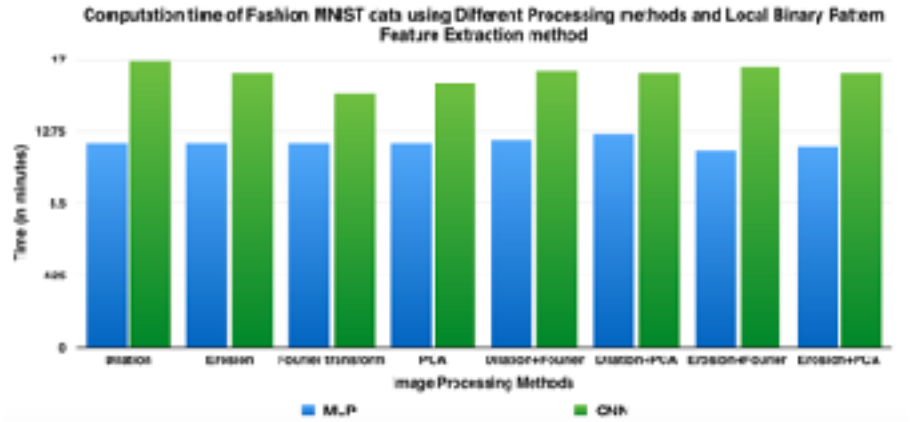



**Figure 78 : Computation time of Fashion MNIST data using different processing methods and Local Binary Pattern for Feature Extraction**

| | MLP | CNN |
|---|---|---|
| Dilation | 59 | 59 |
| Erosion | 61 | 61 |
| Fourier transform | 65 | 65 |
| PCA | 65 | 63 |
| Dilation+Fourier | 59 | 60 |
| Dilation+PCA | 54 | 56 |
| Erosion+Fourier | 60 | 61 |
| Erosion+PCA | 61 | 61 |

**Table 10 : Accuracy of Fashion MNIST data using different processing methods and Peak Local Maxima for Feature Extraction**

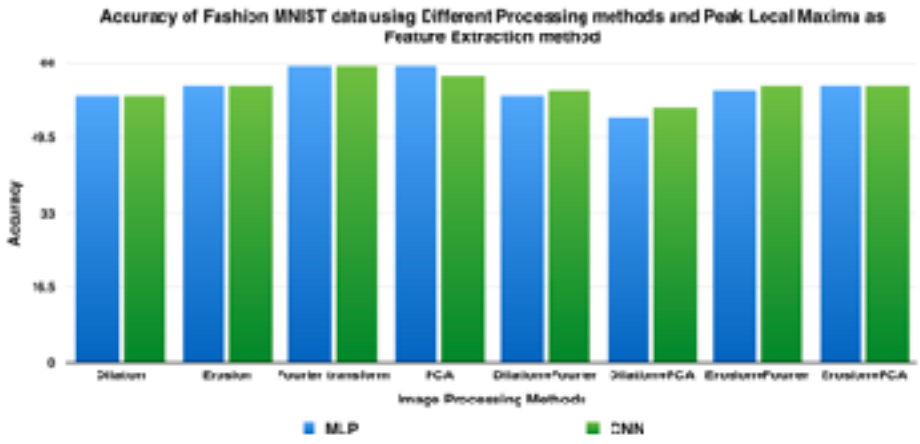



**Figure 79 : Accuracy of Fashion MNIST data using different processing methods and Peak Local Maxima for Feature Extraction**

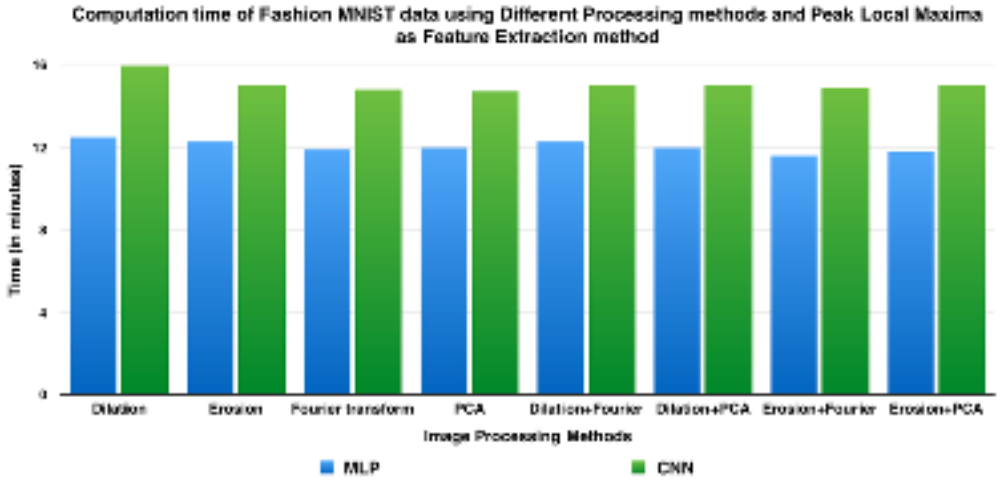



**Figure 80 : Computation time of Fashion MNIST data using different processing methods and Peak Local Maxima for Feature Extraction**

## CONCLUSION

From the above results, it can be observed that Classification using that the Accuracy of the dataset is not very good after processing it, but the Computation time was found to be decreased.

After processing of the dataset, Sobel edge detection feature extraction method performed better overall in comparison to other methods.

It can also be observed, that even though some datasets look similar after applying Feature Extraction method, they have different accuracies.

Overall, MNIST and Fashion MNIST dataset do not require any kind of processing but they can be classified using an appropriate Feature Extraction technique as shown in my previous project, as they had better results.

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