* **System Specification:**

**Epoch = 147**

**η = 0.1**

**momentum= 0.008**

**initial weights = randomly between -0.0823 to 0823**

**hidden layers= 1**

**hidden layer neurons= 100**

**output layer neurons = 784**

**activation function= Sigmoid**

**Training stopping criteria = Error in range around 0.015**

Learning rate was ranged and also the number of epoch. A higher learning rate seemed to perform better and thus was chosen. The system took very long to train and produce output earlier momentum and thus that was increased as well.

* **Results**:

1. Bar Graph of Training and Test set error:

Chart, bar chart

Description automatically generated

*Fig 1.1: Bar graph of Test and Train set*

1. Bar Graph of Training and Test Error on each digit:

Chart, bar chart

Description automatically generated

*Fig 1.2: Bar graph of Test and Train set error on individual digits from 1 to 9*

1. Graph of Training loss over epoch:

Chart

Description automatically generated

*Fig 1.3: Line graph of error over epoch. Error after every 5 epoch is denoted by red dot.*

* **Features:** Hidden layer neuron features from Homework 5 and Homework 4.

A picture containing text

Description automatically generated

*Fig 1.4: Features of hidden neurons of HW5*

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Description automatically generated

*Fig 1.5: Features of hidden neurons of HW4*

As HW4 was a classification problem we do not expect any digit to be learned by any hidden layer neuron. So, the weights of Hw4 do not resemble any digit.

* **Sample output:**

Graphical user interface, application

Description automatically generated

*Fig 1.6: Output generated by the Network on row 1 to the randomly selected input, row2.*

* **Analysis of Result:**

The system performs reconstruction of images but will require high processing time for lowest error and sharp final images. The network requires a lot more training compared to HW4 as it is no longer a classification problem. The network consisted of 1 hidden layer with 100 hidden neurons. The hidden neurons learned few numbers of on which they performed best. Numbers like 4 5 1 7 were learned easily, reason being their structure. The numbers like 2 6 9 3 were comparatively difficult to reconstruct.