Project Development Phase
Sprint – 3

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Team ID	PNT2022TMID24826IBM
Project Name	Project - A novel Method for Handwritten Digit Recognition System

NEURAL NETWORK BASED HANDWRITTEN DIGIT RECOGNITION

Artificial Neural Network system is used to recognize ten different handwritten digits. These are digits from zero to nine. Here, back-propagation neural network is used to train all the data. The major problem is the digits are handwritten; therefore it is subject to enormous variability. Digits were written by different people, using a great variety of sizes, styles, and instruments. Back-propagation can be applied to real image recognition problems without a complex pre-processing stage, which requires a detailed engineering. The learning network is fed directly with images rather than feature vectors. Before inputting the data into the network, the image has to be closed first so there would have no minor holes. Then the image is resized to 16 X 16 pixels. Afterwards, the image is thinned so only the skeleton remains. When the skeleton image is obtained, the horizontal, vertical, right diagonal, and left diagonal histogram of the image is determined. Then the histograms are concatenated into one large integer sequence. The integer sequence is the digit representation [6]. This is fed into the neural network. A three-layered neural network issued. This is 94 input units, 15 hidden units, and 10 output units (Appendix A for picture format)
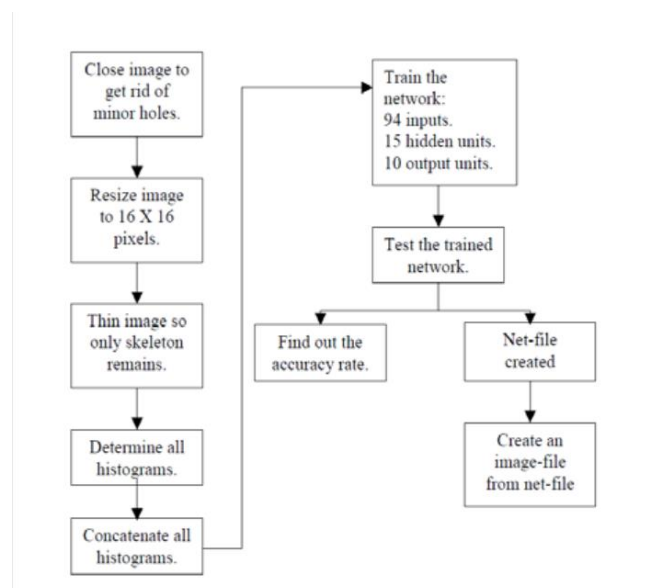
An image, which contains 100 samples of number, is fed into the system to train and test. They are 100 samples of the same number with different writing styles. Then a net-file is created and can be used to create an imagefile. This image-file shows the recognized number. 4.1 Handwritten Digit Recognition With Neural Networks

- **Handwritten digit recognition**

Handwritten digit recognition is a created system that is used to recognize handwritten digits. The handwritten digit images get transformed into histograms and these histograms are fed into a neural network. This neural network outputs scores for matching the input digit against the ten possible digits (0-9). The data is trained and tested and it outputs the accuracy rate. The results can show us which numeral needs more training to reach high accuracies and which numeral the system had a difficulty to identify.

- **Neural Network Digit Recognition System**
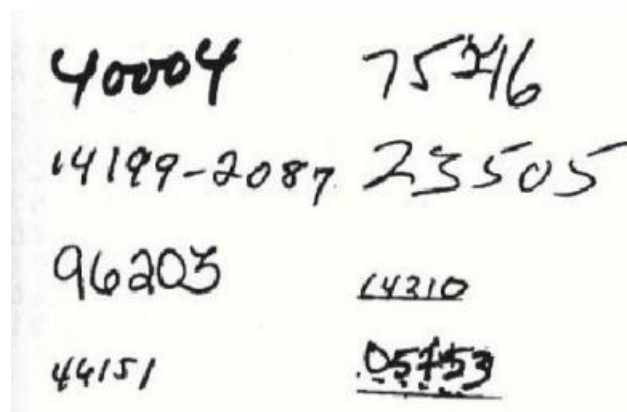
Neural Network Digit Recognition System In order to have a learning task that is reasonably workable, a great amount of pre-processing of the digits is carried out using conventional Artificial Intelligence (AI) techniques. This is done before the digits are fed to the ANN. The difficult task is there are some handwritten digits that often run together or not fully connected. Numeral 5 is an example. But once these tasks have been carried out, the digits are available as individual items. But the digits are still in different sizes. Therefore a normalization step has to be performed so we can have to have digits in equal sizes. After the digits are normalized, they are fed into the ANN. This is a feed-forward network with three hidden layers. The input is a 16 x 16 array that corresponds to the size of a normalized pixel image. The first hidden layer contains 12 groups of units with 64 units per group. Each unit in the group is

connected to a 5 x 5 square in the input array and all 64 units in the group have the same 25 weight values. The second hidden layer consists of 12 groups of 16 units. This layer operates very similar to the first hidden layer, but now it seeks features in the first hidden layer. The third hidden layer consists of 30 units that are fully connected to the units in the previous layer. The output units are in turn fully connected to the third hidden layer.