**A NOVEL METHOD FOR HANDWRITTEN DIGIT RECOGNITION SYSTEM**

**LITERARURE SURVEY**

[1] Handwritten digit recognition is the ability of a computer to recognize the human handwritten digits from different sources like images, papers, touch screens, etc, and classify them into 10 predefined classes (0-9). The models with low accuracy are not suitable for real-world applications. Methods like SVM, MLP, CNN and KNN are some machine learning and deep learning algorithms. In SVM, all the features are plotted and classification is performed using hyperplanes that separate the classes correctly. The MLP algorithm uses input layer, hidden layer and output layer. Each layer consists of several nodes that are also formally referred to as neurons and each node is interconnected to every other node of the next layer. The number of hidden layers may increase according to the problem with no restrictions to the number of nodes. The CNN is widely used for image processing where input image is given in small chunks rather than pixels at a time, to detect uncertain patterns more efficiently. CNN contains 3 layers namely, an input layer, an output layer, and multiple hidden layers which include Convolutional layers, Pooling layers (Max and Average pooling), Fully connected layers (FC), and normalization layers. After implementing all the three algorithms that are SVM, MLP and CNN, it is found that SVM has the highest accuracy while training data and CNN has the utmost accuracy while testing the data. SVM took the minimum time for execution while CNN took the maximum running time. Handwritten digit recognition has recently been of much interest among the researchers because of the evolution of various Machine Learning, Deep Learning and Computer Vision algorithms. They compare the results of some of the most widely used Machine Learning Algorithms like CNN- convolution neural networks and with Deep Learning algorithm like multilayer CNN using Keras with Theano and Tensorflow. MNIST is a dataset which is widely used for handwritten digit recognition. The dataset consists of 60,000 training images and 10,000 test images. The artificial neural network can almost mimic the human brain and are a key ingredient in image processing field. For example, Convolution Neural network with back propagation for image processing. The applications where handwritten digit recognition can be used is banking sector where it can be used to maintain the security pin numbers, it can be also used for blind peoples by using sound output.

[2] Md. Anwar Hossain and Md. Mohan Ali state that CNN is an important tool when it comes to learning deep learning with a NN. Convolutional Neural Networks are a special kind of multi-layer neural networks designed to recognize visual patterns directly from pixel images with minimal pre-processing. Convolution is filtering the image with a smaller pixel filter to decrease the size of the image without losing the relationship between pixels. Max Pooling is one of the most common pooling techniques. A fully connected network is in any architecture where each parameter is linked to one another to determine the relation and effect of each parameter on the labels. All these convolution layers, pooling layers and fully connected layers are stacked. The pre-processed data is fed to the model. CNN transforms the original image layer by layer from the original pixel values to the final class scores.

[3] Alexander K. Seewald talks about a general weakness in present intelligent image analysis systems, calling it ‘brittleness’ in AI terminology. He has investigated two new aspects of such systems, they are essential training set size i.e., the relation between training set size and accuracy/error rate so as to determine the number of labelled training samples that are essential for a given performance level and dataset-independence i.e., how well models trained on one sample dataset for handwritten digit recognition perform on other sample datasets for handwritten digit recognition after comprehensive normalization between the datasets. He says that small differences in the pre-processing methods which have not been documented in sufficient detail may be responsible for this effect. Another explanation might be that idiosyncrasies of the specific dataset used for training are learned as well and hamper the generalization ability of the underlying learning algorithm. This effect is observed independently of learning algorithm or feature representation.

[1] Handwritten Digit Recognition using Machine and Deep Learning Algorithms by Ritik Dixit of Computer Science and Engineering, Rishika Kushwah of Computer Science and Engineering, Samay Pashine of Computer Science and Engineering, Acropolis Institute of Technology & Research, Indore, India, 23 June 2021

[2] Recognition of Handwritten Digit using Convolutional Neural Network (CNN), By Md. Anwar Hossain & Md. Mohon Ali, Pabna University of Science & Technology, 2019

[3] On the Brittleness of Handwritten Digit Recognition Models, Alexander K. Seewald, 30 Nov 2011