# LITERATURE SURVEY FOR HANDWRITTEN DIGIT RECOGNITION

**[1]** Eva Tuba, Nebojsa Bacanin .This paper describes an algorithm for handwritten digit recognition based on projections histograms. Classification is facilitated by carefully tuned 45 support vector machines (SVM) using One Against One strategy. Their proposed algorithm was tested on standard benchmark images from MNIST database and it achieved remarkable global accuracy of 99.05%, with possibilities for further improvement.

**[2]** Cheng-Lin Liu,K. Nakashima,H. Sako,H. Fujisawa.This paper presents the latest results of handwritten digit recognition on well-known image databases using the state-of-the-art feature extraction and classification techniques. The tested databases are CENPARMI, CEDAR, and MNIST. On the test dataset of each database, 56 recognition accuracies are given by combining 7 classifiers with 8 feature vectors. All the classifiers and feature vectors give high accuracies. Among the features, the chain-code feature and gradient feature show advantages, and the profile structure feature shows efficiency as a complementary feature. In comparison of classifiers, the support vector classifier with RBF kernel gives the highest accuracy but is extremely expensive in storage and computation. Among the non-SV classifiers, the polynomial classifier performs best, followed by a learning quadratic discriminant function classifier. The results are competitive compared to previous ones and they provide a baseline for evaluation of future works.

**[3]** U. Ravi Babu,Y. Venkateswarlu,Aneel Kumar Chintha.This paper presents a new approach to off-line handwritten digit recognition based on structural features which does not require thinning operation and size normalization technique. This paper uses four different types of structural features namely, number of holes, water reservoirs in four directions, maximum profile distances in four directions, and fill-hole density for the recognition of digits. The digit recognition system mainly depends on which kinds of features are used. The main objective of this paper is to provide efficient and reliable techniques for recognition of handwritten digits. A Euclidean minimum distance criterion is used to find minimum distances and k-nearest neighbor classifier is used to classify the digits. A MNIST database is used for both training and testing the system. 5000 images are used to test the proposed method a total 5000 numeral images are tested and get 96.94% recognition rate.

**[4]** Chao Zhang,Zhiyao Zhou,Lan Lin.This paper proposes a new type of handwritten digit recognition system based on convolutional neural network (CNN). In order to improve the recognition performance, the network was trained with a large number of standardized pictures to automatically learn the spatial characteristics of handwritten

digits. For model training, according to the loss function, the convolutional neural network continuously updates the network parameters with the data set in MNIST, which contains 60,000 examples. For model tests, the system uses the camera to capture the pictures composed of the images generated by the test data set of MNIST and the samples written by different people, then continuously processes the captured graphics and refreshes the output every 0.5 seconds.

**[5]** Rohan Sethi,Ila Kaushik.This paper is to demonstrate and represent the work which is related to hand-written digit recognition. The hand-written digit recognition is a very exigent task. In this recognition task, the numbers are not accurately written or scripted as they differ in shape or size; due to which the feature extraction and segmentation of hand-written numerical script is arduous. The vertical and horizontal projections methods are used for the purpose of segmentation in the proposed work. SVM is applied for recognition and classification, while Convex hull algorithm is applied for feature extraction.

**[6]** Malathy. S,C N Vanitha,Nirdhum Narayan,Rajesh Kumar,Gokul. R. In the paperwork, the speech output feature is integrated along with the text output. Convolutional Neural Network model is applied in the image classification. The dataset used to train and test is the MNIST dataset. There are various applications of handwritten digit recognition in real time. It is applied in detection of vehicle number, reading of bank cheques, the arrangement of letters in the post office.

**[7]** Shadman Sakib. This paper is to observe the variation of accuracies of CNN to classify handwritten digits using various numbers of hidden layers and epochs and to make the comparison between the accuracies. For this performance evaluation of CNN, we performed our experiment using the Modified National Institute of Standards and Technology (MNIST) dataset. Further, the network is trained using stochastic gradient descent and the back-propagation algorithm.

**[8]** Savita Ahlawat,Amit Choudhary. This paper is to develop a hybrid model of a powerful Convolutional Neural Networks (CNN) and Support Vector Machine (SVM) for recognition of handwritten digits from MNIST dataset. The proposed hybrid model combines the key properties of both the classifiers. In the proposed hybrid model, CNN works as an automatic feature extractor and SVM works as a binary classifier. The MNIST dataset of handwritten digits is used for training and testing the algorithm adopted in the proposed model. The MNIST dataset consists of handwritten digits images which are diverse and highly distorted. The receptive field of CNN helps in automatically extracting the most distinguishable features from these handwritten digits.

The experimental results demonstrate the effectiveness of the proposed framework by achieving a recognition accuracy of 99.28% over MNIST handwritten digits dataset.

**[9]** L. Bottou,C. Cortes,J.S. Denker,H. Drucker.This paper compares the performance of several classifier algorithms on a standard database of handwritten digits. We consider not only raw accuracy, but also training time, recognition time, and memory requirements. When available, we report measurements of the fraction of patterns that must be rejected so that the remaining patterns have misclassification rates less than a given threshold.

**[10]** S. Bernard, S. Adam, L. Heutte. In the pattern recognition field, growing interest has been shown in recent years for multiple classifier systems and particularly for bagging, boosting and random sub-spaces. Those methods aim at inducing an ensemble of classifiers by producing diversity at different levels. Following this principle, Breiman introduced in 2001 another family of methods called random forest. Their work aims at studying those methods in a strictly pragmatic approach, in order to provide rules on parameter settings for practitioners. For that purpose we have experimented with the forest-RI algorithm, considered as the random forest reference method, on the MNIST handwritten digits database. In this paper, we describe random forest principles and review some methods proposed in the literature. We present our experimental protocol and results. They finally draw some conclusions on random forest global behavior according to their parameter tuning.

**[11]** Hong Yan,Minyue Fu,Bailing Zhang,M.A. The adaptive-subspace self-organizing map (ASSOM) proposed by Kohonen is a recent development in self-organizing map (SOM) computation.In this paper, we propose a method to realize ASSOM using a neural learning algorithm in nonlinear autoencoder networks. Our method has the advantage of numerical stability. We have applied our ASSOM model to build a modular classification system for handwritten digit recognition. Ten ASSOM modules are used to capture different features in the ten classes of digits. When a test digit is presented to all the modules, each module provides a reconstructed pattern and the system outputs a class label by comparing the ten reconstruction errors. Our experiments show promising results. For relatively small size modules, the classification accuracy reaches 99.3% on the training set and over 97% on the testing set.

**[12]** V.N. Manjunath Aradhya,G. Hemantha Kumar,S. In this paper, we propose a novel system based on radon transform for handwritten digit recognition. We have used a radon function which represents an image as a collection of projections along various directions. The resultant feature vector by applying this method is the input for the

classification stage. A nearest neighbor classifier is used for the subsequent recognition purpose. A test performed on the MNIST handwritten numeral database and on Kannada handwritten numerals demonstrate the effectiveness and feasibility of the proposed method.

**[13]** L.S. Oliveira,R. Sabourin,F. Bortolozzi,C.Y. Suen discusses the use of genetic algorithms for feature selection for handwriting recognition. Its novelty lies in the use of multi-objective genetic algorithms where sensitivity analysis and neural networks are employed to allow the use of a representative database to evaluate fitness and the use of a validation database to identify the subsets of selected features that provide a good generalization. Comprehensive experiments on the NIST database confirm the effectiveness of the proposed strategy.

**[14]** P. Gallinari,M. Gilloux,A. Bellili.This paper presents an original hybrid MLP-SVM method for unconstrained handwritten digits recognition. Specialized support vector machines (SVMs) are introduced to significantly improve the multilayer perceptron (MLP) performances in local areas around the separation surfaces between each pair of digit classes, in the input pattern space. This hybrid architecture is based on the idea that the correct digit class almost systematically belongs to the two maximum MLP outputs and that some pairs of digit classes constitute the majority of MLP substitutions (errors). Specialized local SVMs are introduced to detect the correct class among these two classification hypotheses. The hybrid MLP-SVM recognizer achieves a recognition rate of 98.01%, for real mail zip code digits recognition task, a performance better than several classifiers reported in recent research.

**[15]** M. Revow,C.K.I. Williams,G.E. Hinton describes a method of recognizing handwritten digits by fitting generative models that are built from deformable B-splines with Gaussian "ink generators" spaced along the length of the spline. The splines are adjusted using a novel elastic matching procedure based on the expectation maximization algorithm that maximizes the likelihood of the model generating the data. This approach has many advantages: 1) the system not only produces a classification of the digit but also a rich description of the instantiation parameters which can yield information such as the writing style; 2) the generative models can perform recognition driven segmentation; 3) the method involves a relatively small number of parameters and hence training is relatively easy and fast; and 4) unlike many other recognition schemes, it does not rely on some form of pre-normalization of input images, but can handle arbitrary scalings, translations and a limited degree of image rotation. We have demonstrated that our method of fitting models to images does not get trapped in poor local minima. The main disadvantage of the method is that it requires much more computation than more standard OCR techniques.