

# Hand Digit Recognition Using ML

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## ABSTRACT

In this digital world, everything, including documents and notes, is stored digitally. There is a requirement to convert these digital documents into processed information. This operation is called handwritten digit recognition (HDR). Digitally scanned documents can be processed and classified to identify handwritten words as digital text and then saved in a document format using computer fonts for everyone to read correctly. This article describes the use of classifiers such as KNN, SVM, and CNN for HDR. These classifiers are trained on predefined data sets and then used to convert digitally scanned documents into computer document format. The scanned document goes through four different recognition stages where the images are pre-processed, segmented, and then recognized by a classifier. The mnist dataset is used to educate the version. This article describes a complete CNN classifier. CNNs have been found to be very accurate in recognizing handwritten digits because this algorithm is built specifically for image recognition, but there is still room for performance improvements in terms of accuracy, complexity and time.

**Keywords:** Hand-Digit-Recognition, HDR-Model, Hand-Written-Text-Recognition using ML, CNN

## I. INTRODUCTION

Convolutional Neural Networks(CNN) is most well know algorithm. It assigns weights to various parts of the image and is very capable of discerning one image from another same kind of image. Good delicacy has been achieved for handwritten integers recognition by using Convolutional Neural Networks. Mammalian system of visualization is taken into consideration to produce CNN architecture. CNN is created by D.H. Hubel in 1962. Two algorithms with name gradient descent & backpropagation are applied to train the model. Character images of handwritten digits are used as input. Artificial neural network( ANN) consists of one input subcaste, one output

subcaste and some layers which live in between input subcaste and output subcaste, these middle layers are isolated layers. CNN and ANN are very analogous to each other. CNN deep learning algorithm worked on analysis of visual images.

CNN can be used in operations like discovery of object, identification of face, in the field of robotics, videotape processing, segmentation, in the field of pattern recognition, processing of natural language, discovery of spam, categorization, speech identification, bracket of digital image etc. Object Character Recognition (OCR) is used on published or proved letters to convert them into textbook. Digital documents can be created by routing and storing information using OCR scanning tools. OCR can be enforced by pattern recognition and through segmentation system. Handwritten number recognition (HDR) is analogous to OCR, just in place of complete object image HDR fetch integers. HDR is light and briskly than OCR. HDR plays an important part in medical attestation, banking attestation, pupil record keeping, taxation. Numerous styles has been used for HDR like NeuroFuzzy Systems (NFS), Artificial Neural Network (ANN), Support Vector Machine (SVM) and deep literacy- grounded classifiers. All the classifiers are furnishing good delicacy but still there is a lot to explore in the field of HDR to further ameliorate the performance. The performance parameters used to find the performance of classifiers are delicacy, running time and computational complexity. The important factor in CNN model is that it completely use the topological information as well as it's steady to introductory metamorphoses like gyration, restatement etc. English Handwriting datasets like Modified National Institute of Norms and Technology (MNIST) are used to calculate the performance of HDR fashion.

## II. METHODOLOGY

### HDR MODELS

The popular models which are used for HDR are KNN (K Nearest Neighbors), SVM (Support Vector Machine), NN (Neural Networks).

#### A. KNN( K Nearest Neighbors):

KNN is used to break retrogression problems and also used as a classifier. In KNN classifier, since calculations are calculated up to the end stage that's why it's also called as late literacy bracket algorithm. And since all the Calculation do locally, it's also called as case-grounded bracket algorithms. There's no training needed before in KNN classifier, as well as there's no conception is performed on training data. KNN algorithm describes categorical value by making use of maturity of votes of K- nearest neighbors, the K value used to differ then. It's plant that votes value changes with change in K value as shown in Fig.1.

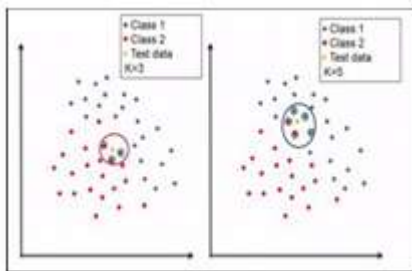


Fig.1. (KNN)

#### B. SVM( Support Vector Machine):

Support Vector Machine is a kind of supervised literacy. It can be used for both retrogression problems and for bracket purpose. SVM make use of optimal hyperactive aeroplane that can be employed to divide it into multiple orders. For 2D spaces, independent variable data points are colluded which are corresponds to dependent variables( 3). After it, bracket is started to find hyperactive aeroplane or direct / nonlinear aeroplane which is used to classify class as shown in Fig.2.

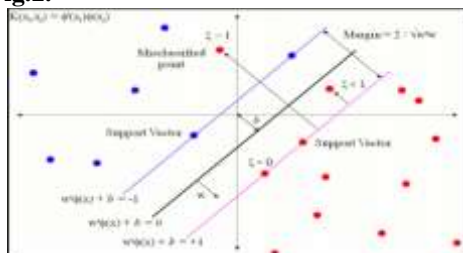


Fig.2. (SVM)

#### C. NN( Neural Networks):

The Neural Networks methodology is inspired from working of brain. It came popular in the field of computational power. NN is nominated as Deep literacy where multilayers are connected together to form a network. Bumps are formed by using these layers. Each knot is subordinated to execute some calculation. This also input into knot's activation function, in order to show environment signal progress into the network for bracket purpose.

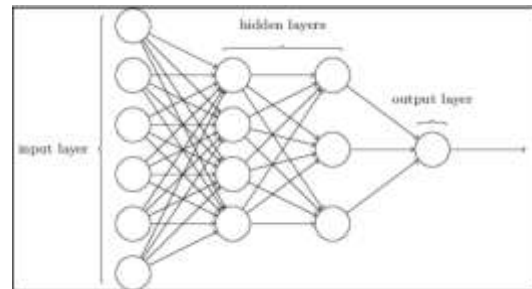


Fig.3. (NN)

## III. MODELLING AND ANALYSIS MNIST DATASET FOR HDR

The standard database used for HDR is MNIST database( Modified National Institute of Norms and Technology database). It contains images of handwritten integers which are veritably constantly used to train classifiers for image processing operations. Machine literacy algorithms also use this data base veritably constantly. This database has training image database of images and testing image database of images. Some of them are shown in Fig.4 below. Where 50 of the images are taken from MNIST's database. Many inquiries have been done on it to achieve good delicacy.



Fig.4. (MNIST DATASET)

### Convolutional Neural Networking (CNN)

The CNN classifier is veritably popular to perform HDR. CNN is a 7 subcaste convolutional network where there's one input subcaste also five layers which are hidden and at last one affairlayer. The size of input subcaste is 28 by 28 pixel that's 784 neurons can be transferred to its input. All the input images are greyscale in nature where intensity value vary from 0 to 255, then 0 represents black and 1 represents white.

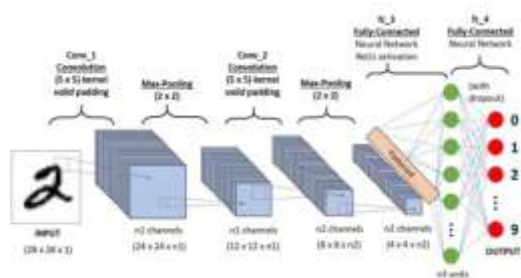


Fig.5. (CNN STEPS)

CNN is kind of ANN with feed forward system. Connectivity in CNN is inspired by the association of the beast visual cortex. CNN has numerous neurons that carry two parameters which are learnable weights & impulses. Some input is handed to each neuron and it performs operations like fleck product and performs it withnon-linearity.

#### Layers of CNN

There are numerous layers in CNN. Deep leaning is a use of all these layers in replication. The 3 order of CNN layers can be explained as:

- 1) Input Layer: The raw pixel values of digital image are carried by input subcaste.
- 2) Convolutional Layer: A result of input block neuron subcaste is supplied into complication subcaste. There are numerous pollutants defines for this subcaste by stoner. The sludge with window size of 5x5 is used for input pixels and it gives out the loftiest intensity pixels in affair.
- 3) Remedied Linear Unit Layer: The function of this subcaste to pass image pixel into activation function element wise. Back propagation is applied in CNN, this leads to change in values of image pixel, in order to amend it ReLU function is applied.
- 4) Pooling Subcaste: Down slice is performed on spatial confines like range and height by this subcaste. The affair comes in the form of volume.
- 5) Completely Connected Subcaste: Calculation of score of classes is performed at this subcaste. It computes outside of score secured by input integers.

### STAGES FOR HDR

There are following stages to perform HDR using CNN. It has 4 stages as given below.

- 1) Pre-Processing in this stage, multiple operations are performed on input image. This stage is to make image ready for segmentation. The operations like noise filtering, standardization and image smoothening is performed on the input image. All the images like argentine scale or colored image is first converted into double image. This operation of binarization is performed to limit the volume of data by performing threshold operation on it. The images will look like as shown in Fig. 4 MNIST dataset.
- 2) Segmentation after the completion of pre-processing process, somesub-images are created from the original image data. Now thispre-processed image is divided into small sub images where eachsub-image represents a single number. All the singular number images are resized into pixels. Edge discovery system is applied to perform segmentation process.
- 3) Point Birth at the end of segmentation process, each affair image is shown as a separate matrix where each value represents a single pixel. These matrix representing individual single number is an easiest way of representation for farther stages. This operation of representation eachsub-image into the form of matrix is nominated as point birth stage. This stage is used to remove the data redundancy from the image data.
- 4) Bracket & Recognition in this stage, the formed matrix is taken as input to classifiers to fete the number present in the image. The affair of birth is input into classifiers like KNN, CNN, SVM. These classifiers used trained data to find the possible number present in the image.

### IV. RESULTS

The Fig.6 shows successful implementation of the model.



Fig.6. (Output of Implementation)

## V. CONCLUSION

Handwritten number recognition has immense operations in the field of medical, banking, pupil operation, and taxation process etc. Numerous classifiers like KNN, SVM, CNN are used to identify the number from the handwritten image. as per the review, CNN is furnishing better performance than others. Stages of HDR using CNN classifier is banded in this paper. MNIST dataset correspond of handwritten figures from 0- 9 and it's a standard dataset used to find performance of classifiers. HDR consists of three different stages. First is preprocessing where dataset is converted into double form and image processing has been applied on it. Alternate stage is segmentation where the image is converted into multiple parts. Third stage is point birth where features of image are linked. Last stage is bracket where classifiers like KNN, SVM, CNN are used. Results of HDR is bettered a lot by using CNN classifier but it can be bettered further in terms of complexity, duration of prosecution and delicacy of results by making combination of classifiers or using some fresh algorithm with it.

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