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# Review On Handwritten Character Recognition

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**ABSTRACT:** Deep learning has recently changed the face of machine learning by offering it a huge artificial intelligence boost due to the proliferation of Artificial Neural Networks (ANN). Because of its wide range of applications in domains like surveillance, health, medicine, sports, robotics, drones, etc., deep learning is remarkably used in a number of different sectors. The Handwritten Digit Recognition is one such ability of computers to recognize human handwritten digits. Because handwritten numerals are imprecise and can be generated with a variety of products, it is a tedious work for the machine.

The goal of this project is to provide the solution to this problem which uses the image of a digit and recognizes the digit present in the image by using the concept of Convolutional Neural Network. In this project, we train our model using Modified National Institute of Standards and Technology (MNIST) dataset. This dataset is trained using convolutional neural network algorithm with the help of SVM which is python library for extensive computation of neural nodes supported by Matplotlib . Gait training, a more accurate model is constructed for iterative testing. With this formed model, we will be able to predict the handwritten Char and Digits in an image. Once model gets the desired testing results, a GUI is developed for users where they can make their inputs either by drawing the digits by themselves or inserting an image file which consist of handwritten digits to get the prediction and accuracy percentage from my model.

## *I.* INTRODUCTION

Available in Full Text In many user authentication analysis applications, handwritten digit recognition is a crucial part. Due to the variances in the dimension, thickness, style, and orientation of the handwritten digits. Therefore these challenges are to be faced to resolve this problem in my project. The objective of this project is to build a Graphical User Interface (GUI) in which we can draw the digit and recognize it straight away. I will be using a special type of deep neural network that is Convolutional Neural Network which is applied in analysing visual imagery where large set of pixel data in images are converted to conserve useful data of images which can be fed as input layer data to Artificial Neural Network for training purpose.
After that system will use hidden layers of CNN to develop a model for handwritten digit recognition. I will apply a 7 layer LeNet-5 Convolution Neural Network algorithm on Modified National Institute of Standards and Technology (MNIST) dataset which includes handwritten digits total of 70,000 images.This Neural Network library is written in Python and has been entitled Keras. The network is trained utilizing stochastic gradient and the backpropagation algorithm, then tested by using forward algorithm. Once the model is ready, user can input their image which consist of digit on our GUI and they will get correct prediction of their input.

## II. PROBLEM STATEMENT

The following are the restrictions which computers confront whenever striving to identify number and composition:

• The Handwritten Digits or Characters are not always of the same size, width, orientation and justified to margins as they differ from writing of person to person.
• The similarity between digits such as 1 and 7, 5 and 6, 3 and 8, 2 and 7 etc. So, classifying between these numbers is also a major problem for computers.
• The formation and appearance of the digits are also impacted by the distinctiveness and variety from each user's handwriting.

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## III. LITERATURE SURVEY

Someoftheworksinthefieldofhandwrittendigitrecognitionhavebeenlistedbelow:
[1] Pal and Singh utilized multilayer perceptron (MLP) for recognizing handwritten Englishcharacters and achieved accuracy up to 94% and improved computation time for training thedataset.

[2] Dutt and Dutt demonstrated multilayer CNN using Keras and Theano libraries whichattained98.7%recognitionaccuracyonMNISTdataset.

[3]GhoshandMagharididcomparative study on three neural network approaches demonstrating that DNN was the bestalgorithm with 98.08% accuracy. However, every neural network has some error rate due tosimilarityindigitshape (e.g.3and8and6and9).

[4] Hamid have performed handwritten digit recognition over MNIST dataset using CNN,SVM (Support Vector Machines) and KNN (K-Nearest Neighbourclassifiers. In their work,KNNandSVMpredictedtheoutcomescorrectlyondatasetsbut Multilayerperceptronfailstorecognize the digit 9 due to non-convex function as it gets stuck in the local minima. It wasconcludedthatthe accuracywouldimprovebyusingCNN withKeras .

[5] Deep Convolutional Neural Networks for Image Classification: A Comprehensive ReviewScientificFigure ResearchGate

LeNet-5 Architecture we used in this project was taken from ref. which is going to formcore partofourmodel.

[6] Bag et al propose a method to improve classificationperformance on Bangla Basic characters using topologicalfeatures derived from the convex shapes of various strokes.

[7] Das et al. describes handwritten Bangla Characterrecognition using a soft computing paradigm embedded in atwo pass approach. More specifically highly misclassifiedclasses were combined to form a single group in the first passor coarse classification. In the second pass, group specificlocal features were identified using Genetic Algorithm basedregion selection strategy to classify the appropriate classfrom the groups formed in the earlier pass. They used twodifferent sets of features –a) Convex hull based featuresb) Longest run based features with Support Vector Machines(SVM), a well known classifier for this purpose.They reported a recognition accuracy of 87.26% on a datasetof handwritten Bangla characters consisting of basiccharacters, compound characters and modifiers.

[8] Sarkh el et al. approached the issue from a perspective ofmulti-objective based region selection problem where themost informative regions of character samples were used totrain SVM classifiers for character recognition. Twoalgorithms for optimization, specifically a Non-dominatedSorting Harmony Search Algorithm and Non-dominatedSorting Genetic Algorithm II were used to select the mostinformative regions with the objective of minimalrecognition cost and maximal recognition accuracy. Arecognition accuracy of 86.65% on a mixed dataset of Bangla numerals, basic and compound characters was reported.

[9] Das et al. described a Quad tree based features used forrecognition of 55 frequently occurred compound characterscovering 90% of the total of compound characters in Bangcausing an Multilayer Perception (MLP) classifier.
[10 ]Pradeep et al. proposed neural network basedclassification of handwritten character recognition system.Each individual character is resized to 30 X 20 pixels forprocessing. They used binary features to train neuralnetwork. However such features are not robust. In postprocessing stage, recognized characters are converted toASCII format. Input layer has 600 neurons equal to number

## III. METHODOLOGY

[A] DESCRIPTION

Deep Learning has emerged as a central tool for self-perception problems like understanding images, voice from humans, robots exploring the world. The project aims to implement the concept of Convolutional Network which is one

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of the important architecture of deep learning.
• Image Feature Extraction

During our method, we use CNN LeNet-5 [5] to obtain more diverse features from each handwritten digit image. The LeNet architecture is acknowledged as the first convolutional neural network architecture. The LeNet-5 in Fig. offers indications. 1 feature maps are constructed by each layer. Thereby, we may attain additional characteristics by employing other tactics.
common methods. The LeNet-5 architecture is a fantastic pick for identifying numerals.
The LeNet-5 consists of two components: feature extraction and categorization, which would both be used to characterize objects. Given an image of 32 × 32 × 1, firstly, a convolution layer with six 5 × 5 filters with the stride of 1 is used and an output matrix of 28 × 28 ×6 is generated. With the stride of 1 and no padding, the feature map is reduced from 32 × 32 to 28 × 28. The dimension is then shrunk by a factor of 2 and average pooling with a filter width of 2 and a stride of 2 yields in with 14 × 14 × 6. Furthermore, another convolution layer with sixteen 5 × 5 filters is used leading to an output matrix of 10 × 10 × 16. Then another pooling layer is involved and ends up with an output matrix of 5 × 5 × 16. Therefore, we extract sixteen 5 × 5 feature maps from each image, and each feature map (5 × 5) is treated as a column vector (25 × 1). Overall, there are two convolution layers, two subsampling layers, and twofully connected layers in the LeNet-5.

[B]Image Classification

Once the feature extraction has been done, Pooled Feature Map is flattened to get fully connected layer. There still are 120 feature maps on this fully associated layer, each spanning 1 x 1.. Each of the 120 units is connected to all the 400 nodes (5x5x16) in the fully connected layer.
Sixth layer is a fully connected layer with 84 units inorder to reduce number of trainable parameters from 48120 (with 120 units layer 5) to 10164.
Finally, there is a fully connected softmax ouput layer y^ with possible values corresponding to the digits from 0 to 9.

[C]GUI development for prediction

After we get the desired testing input, an interface is developed for the purpose of enabling users with a choice to detect the digits character depicted or written in images or drawer respectively. When users opens up the interface, they will be provided with an option to choose whether they wants to draw the digits all by themselves or insert image files from their local directory containing digits.
If users chooses first option, he will be guided to a drawer interface where he can draw digits by themselves and get their digits recognized along with their accuracy.
If users chooses second option, he will be asked to insert image file from their local directory and can get their digits written in image files predicted with optimum accuracy and along with percentage.
So by giving recognized digits as a results against inputs made by users to its users, this project fulfils all its objective

[D] BLOCK DIAGRAM OF PROPOSED SYSTEM

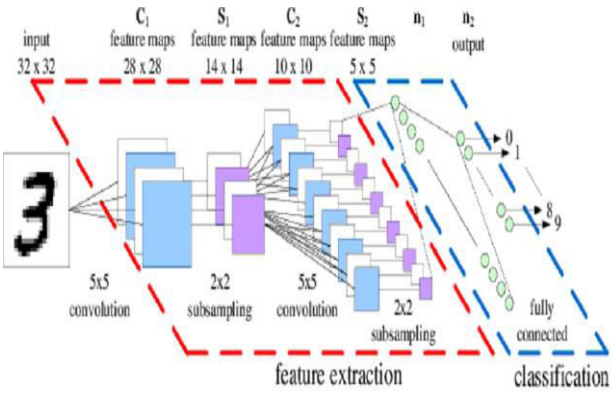


Fig. 1. Proposed System

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## IV. APPLICATIONS

- Digital Libraries
- Reading Postal Address.
- Health Sector.
- Bank forms
- Traffic sign Detection

## V. CONCLUSION

The objectives with which this project was initiated such as to develop handwritten digit recognizing system that enables users to recognize their handwritten digits using this deep learning model, less compuatation intensive efficient model has been achieved. The model which I built got an average accuracy of 98.23%.
Also the underlying problems of not having the same size ,width, orientation, and margin always has been taken care of with the help of computer vision's opencv library's functionalities. The problem of difficulty in distinguishing the difference between digits such as 1 and 7, 5 and 6, 3 and 8 etc has been resolved to a great extent with the opencv's edge detection and contour features. concerns with bright visibility, fuzzy or unclear edges

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