

**A RESEARCH ON IMPROVE HANDWRITTEN CHARACTER
RECOGNITION BY USING CONVOLUTIONAL NEURAL NETWORK**

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Abstract — For image recognition CNN is the most popular learning model. The features like weight sharing strategy and strong relations of the pixels of the image makes CNN best choice for image recognition. The feature extraction and classification can be done simultaneously in deep learning models which has proved very needful compared to the traditional methods. A promising recognition can be obtained by using CNN if we address to certain issues. So in CNN based framework for handwritten character recognition that gives a better performance compared to other CNN based recognition methods.

Keywords- Convolutional neural network, optical character recognition (OCR) , character recognition

INTRODUCTION

Artificial intelligence (AI) is the intelligence of machines and the branch of computer science which aims to create it. It is the science and engineering of making intelligent machines, especially intelligent computer programs.

Artificial intelligence is a field which attempts to build intelligent machines and tries to understand intelligent entities. Intelligence is nothing but it is one type of learning. Intelligence also means that it is not to make no mistakes but quickly to understand how to make them good. There are also three types of learning which are supervised learning, Reinforced learning and unsupervised learning.

Artificial intelligence (AI) works with the help of Artificial Neurons (Artificial Neural Network) and scientific theorems (If-then statements, Logics).Artificial neural networks are composed of interconnecting artificial neurons.

To supplement natural intelligence for e.g. we are building intelligence in an object so that it can do what we want it to do, as for example – robots, thus reducing human labour and reducing human mistakes.

Computers are fundamentally well suited to performing computations, using fixed programmed rules. Artificial machines perform simple tasks efficiently and reliably, which humans are ill-suited to.

AI research is allowing us to understand our intelligent behavior. In this paper we propose a new framework with some new distortion and classifiers from we can get more accuracy and can get less test error rate.

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Neural network is a network which is highly interconnected with a large number of processing elements called neurons. Neural networks possesses characteristics like mapping capabilities or pattern association, generalization, robustness, and parallel and high speed information processing.

Neural networks learn by example. It adopt various learning mechanisms of which supervised learning and unsupervised learning methods turned out to be very popular.

In supervised learning there must be a training data set in which the solution is already known. Supervised learning also includes desired outputs. Where in unsupervised learning, the outcomes are unknown. It does not include desired outputs. Rewards from sequence of actions includes in reinforcement learning.

Step 1: Scanning of Hand written character image.

Step 2: As per requirement Image is converted into gray scale, i.e. To find out the high pressure region grayscale image is required.

Step 3: To resize in standard formate as all character in different size so require to in specific formate.

Step 4: to eliminate the pixels that are not part of the image, noise removal is required.

Step 5: Thinning is a process which is necessary for reducing data and computational time.

Step 6: . The entire closed regions are filled with white pixels which called smoothing.

Step 7: Thresholding creates binary images from grey-level ones by turning all pixels below some threshold to zero and all pixels about that threshold to one.

Step 8: Special features are extracted from test image like ratio of height and width,number of connected component, number of end points, type of end points etc.

Step 9: These features are compared with the original features, which have already been extracted.

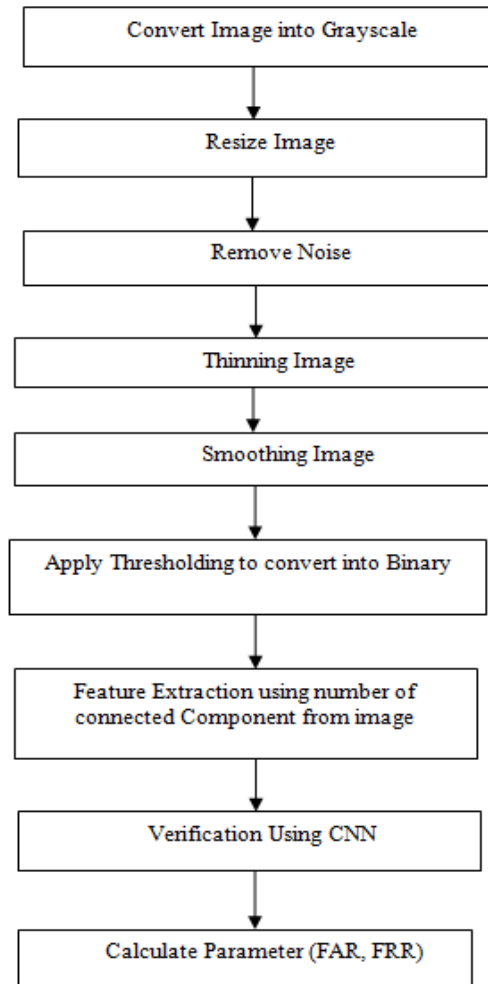
Step 10: Accept or reject after verification.

Step 11: Repeat 1 to 10 step for all image.

Step 12: Calculate FAR and FRR.

FAR (False Acceptance Ratio)

$$\text{FAR} = \text{Sample data} / \text{Total data} * 100$$



I. LITERATURE SURVEY

A. Beyond Human Recognition: A CNN-Based Framework for Handwritten Character Recognition

In this paper, Convolutional neural network (CNN) framework was used for handwritten character recognition. In that framework, proper sample generation, training scheme and CNN network structure was employed according to the properties of handwritten characters. That CNN-based framework achieved better performance compared with other CNN-based recognition methods.

That CNN-based framework mainly consists of three parts: The Sample generation, CNN models and voting. Sample generation used distortions such as local and global distortion. CNN model was for better training and Voting can significantly improve recognition rate. The error-rate by this CNN-based framework for character recognition for MNIST data set was 0.18%. So we can still improve this framework by enlarging the CNN scale or input image size. Also we can find better sample generation methods, training scheme and network structure of CNN.

B. Comparison of learning algorithms for handwritten digit recognition

This paper compares the performance of several classifier algorithms on a standard database of handwritten digits. This paper also compares the relative merits of several classification algorithms for the purpose of recognizing handwritten digits. This paper includes Baseline linear classifier, Baseline Nearest Neighbor classifier, Pairwise linear classifier, Principal component Analysis & Polynomial classifier, Radial Basis function Network, Large fully connected multi-layer Neural network, Letnet1, Letnet4, Letnet5, Boosted letnet4, Tangent Decent classifier (TDC) and Optimal margin classifier (OML) classifiers with their test error rates.

Among them, Boosted letnet4 and Letnet5 has very low test error rate which is 0.7 and 0.9 respectively. As well as training time of K-Nearest neighbor and TDC have zero training time while single layer

net, pairwise net and PCA+quadratic net have less than 1 hour training time. Letnet4 requires least memory and it is also a high accuracy classifier.

C. Best Practices for convolutional neural networks applied to Visual Document Analysis

There are mainly two most important things: first one is getting a training set as large as possible; we expand the training set by adding a new form of distorted data. Second is; Convolutional neural networks are better suited for visual document tasks than fully connected networks. This paper illustrates claims on the MNIST set of English digit images.

This paper shows that neural networks achieve the best performance on a handwriting recognition task (MNIST). And the optimal performance on MNIST was achieved using two essential practices. First, Authors created a new general set of elastic distortions and second, they used convolutional neural network. They also compute a grey level of an object with an example. And the algorithm for evaluating grey level is “bilinear interpolation”. Affine distortions greatly improved results on the MNIST database but the best results were obtained when they used elastic deformation. At the end results shows that they achieved the highest performance known to date on the MNIST data set, using elastic distortion and convolutional neural network.

D. Convolutional neural Network Committees for Handwritten Character Classification.

In this paper a committee of seven CNNs obtains the best results published so far for both NIST digits and NIST letters. And convolutional neural networks are among the most suitable architectures for this task. This paper focus on improving recognition rates using committees of neural networks. And goal is to produce a group of classifiers whose errors on various parts of the training set differ as much as possible. In this paper, there are several experiments with NIST database like; Test error rate on class task, on digits, on letters, on merged letters, on uppercase letters, on lower case letters. It is all committee wise results and error rates for digits are significantly lower than those for letters

III. PROPOSED WORK

Convolutional neural network (CNN) is a supervised deep learning neural network. It is used in various fields like speech recognition, image retrieval, face recognition and character recognition.

Typical convolutional neural network (CNN) is the most popular one especially for image recognition. By using CNN, a promising recognition rate can be obtained. Convolutional neural networks are very similar to ordinary Neural Networks. They are made up of neurons. Each neurons receives some inputs and performs some operations.

A Convolutional neural network (CNN) is a class of deep, feed-forward artificial neural networks. A CNN consists of an input and an output layer, as well as multiple hidden layers. The hidden layers are either convolutional, pooling or fully connected.

Steps for my proposed work which are as follows;

Step 1: Hand written character image is scanned.

Step 2: Image is converted into gray scale as per requirement, i.e. to find out the high pressure region grayscale image is required.

Step 3: To resize in standard formate as all character in different size so require to in specific formate.

Step 4: Noise removal is required to eliminate the pixels that are not part of the image, but contained in the image.

Step 5: Thinning is a process necessary for the reduction of data and computational time.

Step 6: . The entire closed regions are filled with white pixels which called smoothing.

Step 7: Thresholding creates binary images from grey-level ones by turning all pixels below some threshold to zero and all pixels about that threshold to one.

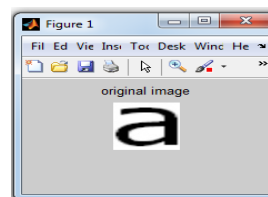
Step 8: Special features are extracted from test image like ratio of height and width, number of connected component, number of end points, type of end points etc.

Step 9: These features are compared with the features of original one, which have already been extracted.

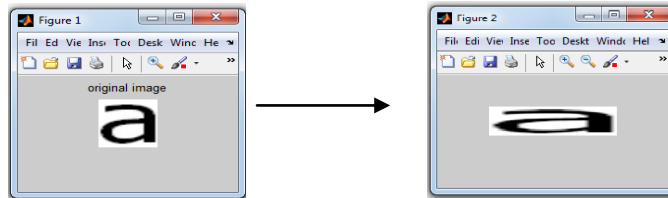
Step 10: Accept or reject after verification.

Step 11: Repeat 1 to 10 step for all image.

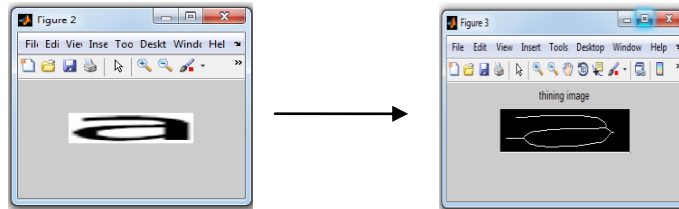
Step 12: Calculate FAR and FRR.



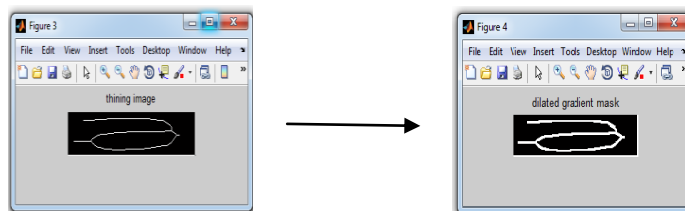
After reading image convert it into grayscale image.



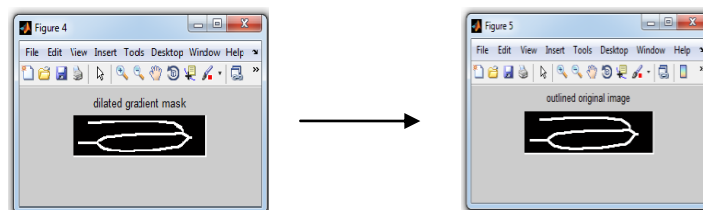
After that image will be resized and noise will be removed here in this step.



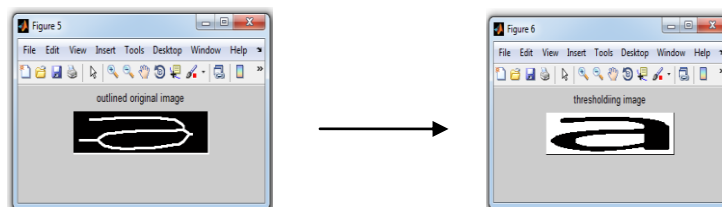
After noise removal image it will give thinning image.



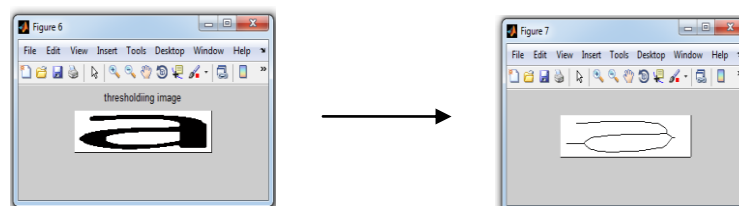
Here after thinning I put one extra step of dilated gradient mark which will increase width of character so that we can clearly find gap or space between handwritten lines.



It will give us smoothing that means outlined original image.



After smoothing image we applied thresholding to convert image into binary so we will get thresholding image.



Here we performed feature extraction using number of connected component from image.

```

Shortcuts | How to Add | What's New
Command Window
1.1402
Warning: The input image is already binary.
> In im2bw at 54
   In proposed_final2 at 120
M =
1.0e+003 *
    0.2481    -0.0517
   -0.0517     2.8442
minIgen =
247.0498
MI =
1.0e+003 *
    0.0010    -0.0517
   -0.0517     2.5972
theta =
1.1402

```

After that we will get some values using CNN which give us perfect result.

The Variable Editor window displays a 19x10 matrix of logical values. The matrix consists of 19 rows and 10 columns, with every cell containing the value 1. The window title is 'Variable Editor - I3' and the variable is identified as 'I3 <52x201 logical>'. The interface includes a menu bar (File, Edit, View, Graphics, Debug, Desktop, Window, Help) and a toolbar with various icons for file operations and debugging.

And as we are considering here character a so for that I manually calculate that it gives result 100% but it may possible that we might get error but that possibility will be rare.

Comparison of previous result and proposed system is as follows:

Method	Error rate (%)
CNN	0.23
Proposed framework	~0.01

IV. CONCLUSION

In this paper we review some effective methods for character recognition and proposed a new steps for handwritten character reconition with the help of Convolutional neural network. Our proposed system can achieve good efficiency then existing system. The purpose of this research is to develop a more effective framework which can give minimum error rate. This proposed system gives better result as compare to previous. We can do work on cursive writing characters because it can generate more error rate so we can do further work on signature also.

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