SHAPE BASED RECOGNITION METHOD for NUMBERS USING CNN

Bhargavi Patel

ME Student

Computer Engineering

Kalol Institute of Technology and Research Centre, Kalol, India

Prof. Shilpa Serasiya

ME (CSE) (Head of the Department)

Computer Engineering

Kalol Institute of Technology and Research Centre, Kalol, India

Abstract: Digital image processing has become vital with the growing requirement of different devices to capture everything around the world. To recognize any object, its shape is extracted and matched with required object or dataset. For object recognition, all the objects are different in nature and they have different label. With this in mind, it has the different name and identity according to the description. My approach is to combine stages of the digital image processing system, to identify a number in ancient languages like Sanskrit. Since the numbers are curved, there must be a specific process to recognize them. In this research, novel method for the classification of freeman chain code using four connectivity and eight connectivity events with deep learning approach is proposed. The existing Freeman Chain Code event data examines methods, sampled gray images of the existing methods are not being properly used, but the voltage image files of three-phase Power Quality data are analyzed by taking up the benefit of the achievement with deep learning concept (Convolution Neural Network) on image file. So, the uniqueness of the planned concept is, classification of image files of voltage waveforms of the three phases of the power grid is done. This is shown that the ancient number image data used for test can be recognized with 100% accuracy as a result. Here planned work is to believe that provide the requirements of the future applications, which are quick and pleasing usual counter measures. My approach will prove relatively better results in terms of precision, accuracy and recall.

IndexTerms **- Freeman Chain Code, Digital Image Processing, Convolution Neural Network, Ancient Numbers.**

I. INTRODUCTION

Ancient language like Sanskrit is gaining more importance in different educational communities due to the presence of ancient scientific and mathematical research work written in this language. In today's world hard to recognize this type of ancient numbers which are broken or torn numbers from ancient literatures. [8]

Image Processing is defined as a process to change an analog image in digital form as well as do various operations on it, to obtain an extracted image or to take out useful information from it. [10] Image processing methods are classified as analog and digital image processing. Uses of analog image processing are for the hard copies same as photographs, printouts etc. Whereas, digital image processing is used for manipulating digital images by computers.[10] This study presents Digital Image pre-processing as Freeman Chain Code with deep neural networks to recognize number.

The shape of objects acts as significant role among the different aspects of visual information. The most shape based image retrieval system extracts the information shape based features vectors from the image query and database image, and computes the similarity measure between both images using spatial distance functions. The minimum distance shows the closest match and specifies the best matched number images to be extracted. There are two types of shape descriptors: region-based and contour-based methods. Region based descriptors utilize the entire pixels within a shape section and they are considered to achieve the shape description; they generally have need of more computation and storage than contour based methods. Contour based shape description can be exploit shape boundary findings here in the contour of an image object and neglect content within the object shape. [9] So here contour based shape descriptor method Freeman Chain Code [2] is used. System uses both 4-connected and 8-connected Freeman Chain Code. Ancient languages numbers for Hindi and Sanskrit are most probably curved in shape. So, find out any small piece of curved shape is detecting using Power Quality event. Power Quality basically used for detection of any diagnose in waveforms. [5]

Artificial Neural Network is defined as algorithms which are inspired by the function and structure of brain. For it, deep learning approach with Convolution Neural Network is used. Convolution neural networks are generally made by a set of layers that may be combined by their features. CNNs utilize a deviation of multilayer designed to necessitate minimum pre-processing. [12] This system matches extracted number image with trained dataset and gives more accuracy.

The rest of this paper is organized as follows: Section 2 describes related work of contour detection using Freeman Chain Code and Convolution Neural network. Section 3 contains proposed flow of the system. Section 4 explains the dataset and experiment results. At last, section 5 provides conclusion to this paper.

II.RELATED WORK

Freeman Chain Code

Contour detection plays vital role in computer vision applications as smart rooms, augmented reality, driver assistance and object based video compression. The phrase contour can be defined as boundary or an outline of an object. Contour detection is important pre-processing step in Digital Image Processing.

Here, chain codes are utilized to represent the edge of an object made out of pixels of usual cells by associated order of straight-line segments of specific direction and length. [2] The object is traversed in clockwise direction. As the edge is traversed, the direction of every one chain segment is specified using the succeeding numbering manner:
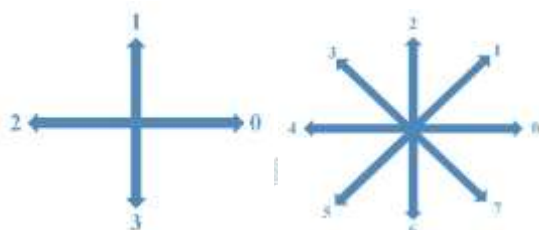

Figure1. 4-Connected and 8-ConnectedFreeman Chain Code [2]

Convolution Neural Network

A deep neural network joins various non-linear processing layers, utilizing simple components working in equivalent. It is motivated by the biological nervous system, and comprises of an input layer, various hidden layers, and an output layer. [12] All layers are interconnected through nodes, or neurons, with every hidden layer uses the output of the earlier layer as its input. The hidden layers of a neural network perform modifications on the information to ultimately consider what its association with the objective variable is.
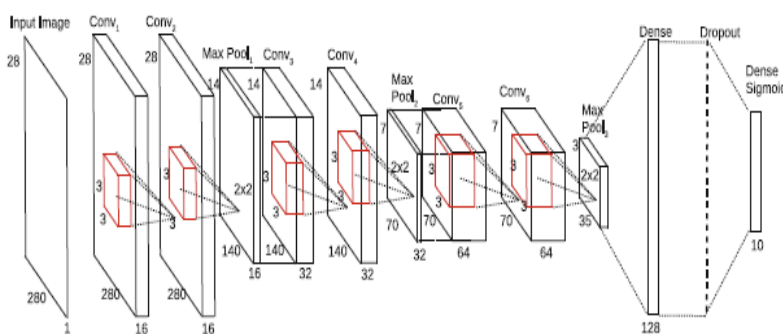
Figure2. CNN model architecture [1]

Convolution Neural Network (CNN) is most well known type of deep neural network. A CNN convolves learned features with input data, and utilizes 2D convolution layers, building this architecture well appropriated to preparing 2D data like images. CNNs can be trained to distinguish diverse features of an image with tens or hundreds of hidden layers. Each hidden layer expands the complexity of the learned image features.

III. PROPOSED FLOW

Contour Detection using Freeman Chain Code

Contour detection of an image is most important step in Digital Image Processing. Freeman Chain Code technique is used for contour detection. Cropped ancient number gray scale image with 32 X 32 pixel is used as an input of the system. According to image it generates different shapes in matrix form then merges all boundary values and gives output to checks condition whether it is best suited for 4-connected or 8-connected. System checks for condition as,

if mat[x][y] == mat_new[4][4] && d != null

It checks for csv conversion and dimension checking for generating array of image. If new generated matrix has 4 dimensions then it goes for 4-connected otherwise it goes for 8-connected. And it gives contour image in csv format for the classification with Convolution Neural Network.

```
1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,32,49,82,124,144,140,117,91,65,36,16,5,1,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,0,0,0,0,187,209,233,248,254,253,246,238,225,189,132,69,23,5,1,0,0,0,0,0
,0,0,0,0,0,0,0,0,0,0,0,255,255,255,252,249,249,250,253,255,255,252,225,144,56,15
```

Figure3. CSV output of contour number image

Recognize number with LeNet-5 Convolution Neural Network

LeNet-5 is a 7-level convolution network that classifies ancient number is in csv file format. Here generated csv file used for process with LeNet-5.

Figure4. LeNet5 Architecture

In this paper, LeNet5 is used for best classifier. It is only used for recognize number. Input for LeNet5 is csv format file with string of chain code of contour number image. Here LeNet-5 process with two convolutional layers, two pooling layers, two fully connected layers and a softmax layer which outputs a recognized number in binary form. Then it will goes for more accurate result to the next step and checks for condition:

if result_output != " " OR result_output != null

Output from system gives a binary output then it goes for stroke variance check which is done by mathematical equation of standard deviation. Here stroke variance gives the output of number which is matched with trained dataset by model. Condition goes wrong if no labeled number is found at this step. At last, removes noise if shows in output image by using scipy with its own library methods and gives final recognized number as an output.

Evaluation

I use precision, recall and accuracy to evaluate the performance of proposed system. A true positive is defined as a result where system accurately anticipates the positive number image class. A true negative is defined as a result where system accurately anticipates the negative number image class. A false positive is defined as a result where system inaccurately anticipates the positive number image class. A false negative is defined as a result where system inaccurately anticipates the negative number image class.

$$Precision = \frac{TP}{TP \ + \ FP}$$

$$Recall = \frac{TP}{TP \ + \ FN}$$

$$Accuracy = \frac{TP \ + \ TN}{TP + TN + FP + FN}$$

IV.RESULTS IMPLEMENTATION

Dataset

Experiments are done over Sanskrit number images of Devanagari dataset. [13] The number image in dataset is gray scale image with 32 X 32 pixels. There are 300 sample number images on each number image. So, totally dataset consist of overall 3000 images. Below shows some of sample number images of dataset.

Table1. Sample number images from dataset

Recognition Results

I have used python language for system with numpy, scipy, pandas library function to classify correct number image. From dataset I have used 100 images for testing purpose and 2900 images as trained dataset. Also testing is done for some number images with both Artificial Neural Network and Convolution Neural Network which is shown below. Result shows the better accuracy with Convolution Neural Network.
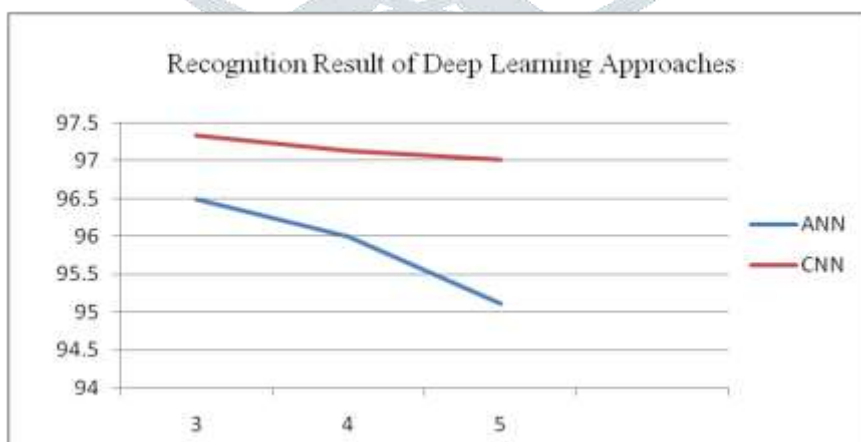
Figure5. Accuracy with different Deep Learning Approaches

I have obtained 97% accuracy on testing dataset in terms of precision, recall and f1-score. As below output shows that, the 0 and 4 digit was more accurately classified around 99% and 98% respectively of the time as shown below.
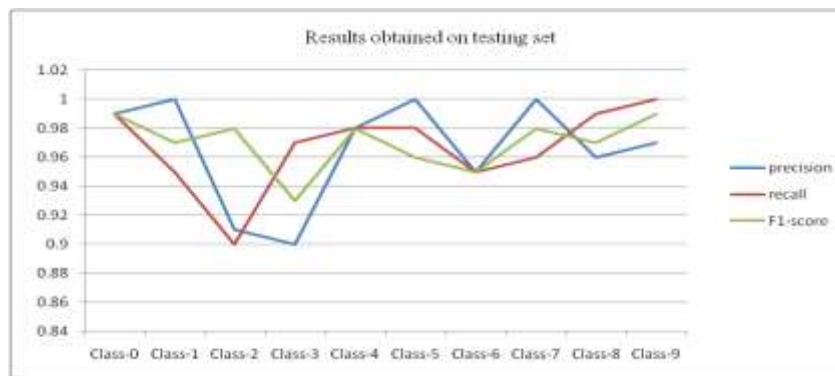
Figure6. Obtained accuracy of testing dataset

V. CONCLUSION

Shape based representation of any number is easily done using 4-connected or 8-connected Freeman Chain Code is shown by this paper. The main idea is to present Freeman Chain Code as a part of image pre-processing step. Deep learning has many approaches as Artificial Neural Network, Convolution Neural Network, Recurrent Neural Network and so many. In this paper, to recognize number I have used LeNet5 Convolution Neural Network model which gives more accurate result with stroke variance check according to my experiment results. From the experiment, I have conducted Sanskrit numbers are recognized by this study and for future aspect can apply for different handwritten Sanskrit and Hindi number recognition.

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