Hindi Digit Recognition

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***Abstract*—In this paper, we briefly discuss a CNN architecture used to predict handwritten Hindi Digits. The results indicated 99% accuracy by the grace of Allah. The experiment was conducted in Google Colab using Devanagari Handwritten Character Dataset from the UCI Repository with a UI for immediately testing with drawn digits by the grace of Allah.**

I. Introduction

Hindi is an Indic language mainly used in India, South East Asia. The Hindi numeral system follows the Arabic Numerals commonly used in English in that there are 10 digits (0 to 9) and some digits such as zero, two and three are almost identical to English equivalents. Some handwritten images of each digit from the dataset are given below insha Allah.

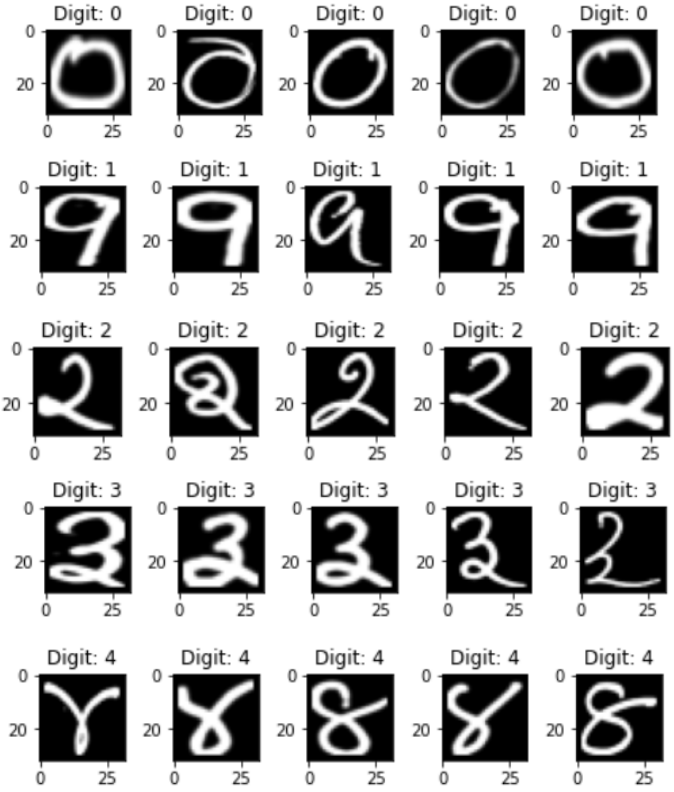

Fig. 1: Samples of digit 0 to 4

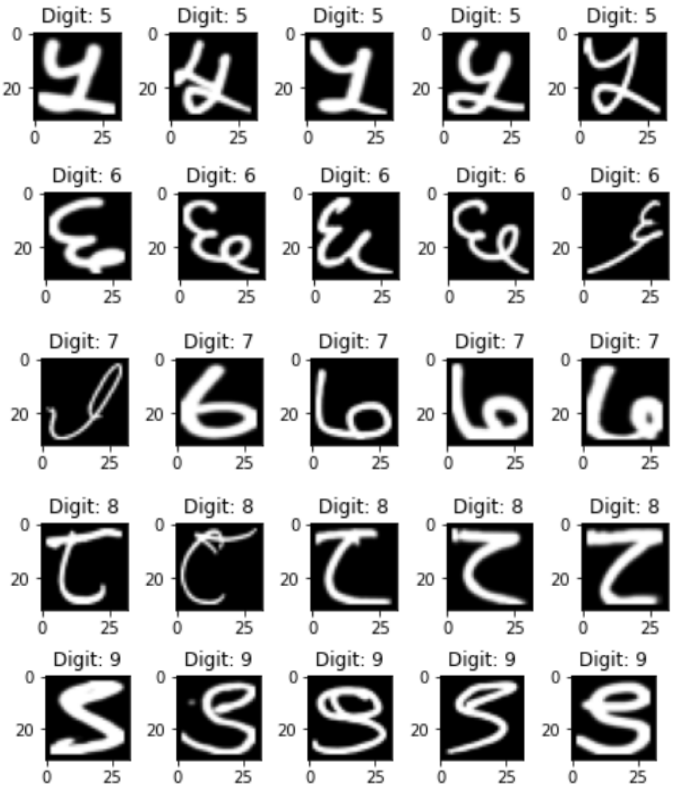

Fig. 2: Samples of digit 5 to 9

II. Literature Review

There are several papers which deal with this problem, like:

- Handwritten Digit Classification in Bangla and Hindi Using Deep Learning by Jishnu Mukhoti, Sukanya Dutta, Ram Sarkar
- Hindi Handwritten Character Recognition from Digital Image using Deep Learning Neural Network by Abhishek Mehta, Dr. Subhashchdra Desai, Dr. Ashish Chaturvedi
- Handwritten Hindi Digits Recognition Using Convolutional Neural Network with RMSprop Optimization by Vijaya Kumar Reddy .R, B. Srinivasa Rao, K. Prudvi Raju

All of them were quite successful in creating good models and methods with a very high degree of accuracy.

III. Methodology

A. Preprocessing

The pictures were taken from Devanagari Handwritten Character Dataset from [1]. The digits folders of the train and test sets were extracted and uploaded as Hindi Digit Dataset to Colab.

Fig. 3: Folder Structure of Dataset

Each digit folder contains many 32 x 32 pixel grayscale pictures of handwritten digits. These were pre-processed by adding each picture along with the label (extracted from the last character of the folder name) to prepare training and testing datasets into Colab.

(a) Digit 0 (b) Digit 1 (c) Digit 2

Fig. 4: Some sample pictures (32 x 32 grayscale) from the dataset

TABLE I: Training and Testing datasets

Type	Train	Test
Total Number of Samples	17000	3000
Number of Samples per digit	1700	300

B. Model Design and Training

The dataset was then stored into numpy arrays. Our aim was to use the keras library in python to design a Convolutional Neural Network (CNN) model to predict Hindi digits written on the screen.

The adam optimiser is used which uses a stochastic gradient descent method.

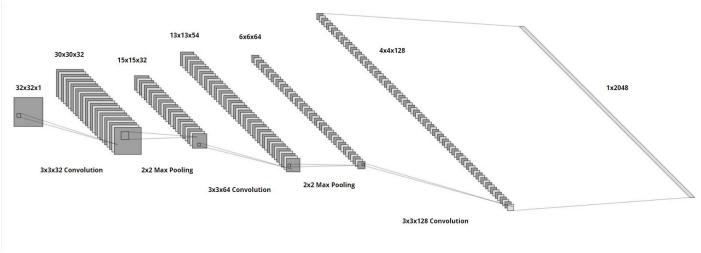

Fig. 5: CNN Model layered structure

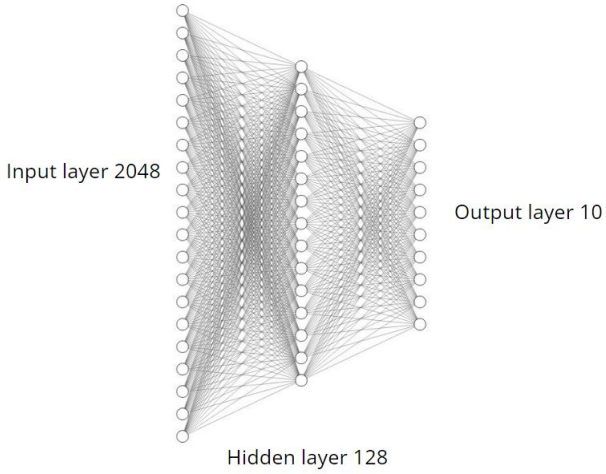

Fig. 6: CNN Model layers simplified view

For all layers ReLu activation function was used as it is simple and fast, except for the last layer where softmax is used. The model was trained over 30 epochs with a batch size of 64. That seemed to give very good results by the grace of Allah.

IV. Result Analysis

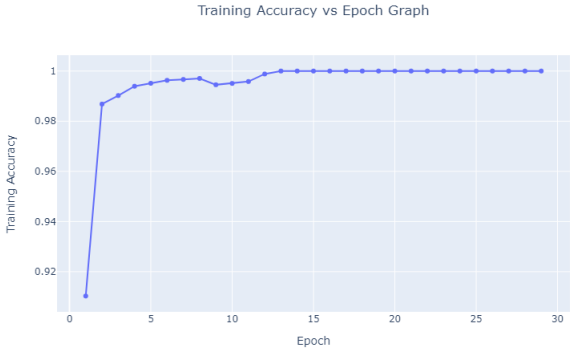

Fig. 7: Training accuracy

Fig. 8: Training loss

TABLE II: Training and Testing accuracy

Type	Train	Test
Number of Samples	17000	3000
Accuracy (Alhamdulillah)	100%	99.5%

V. Drawing Interface

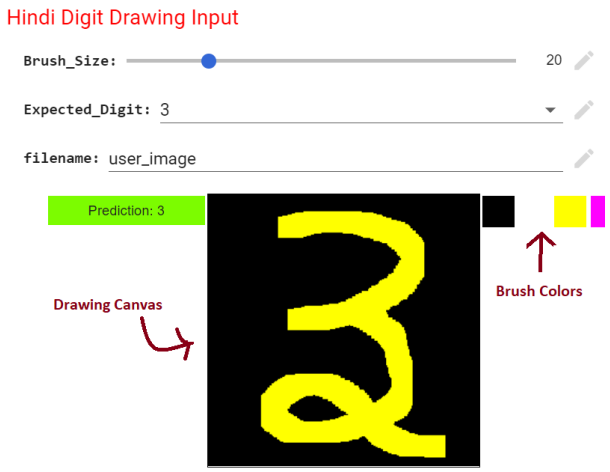

Fig. 9: UI input screen

The UI is a customised version of [2] e.g. the button has been modified to display the predicted digit. The main purpose of the UI is to allow users to draw and test the model's accuracy at first hand. The image from the UI is converted to a 32 x 32 grayscale pixel image and fed into the model for prediction by Allah's will.

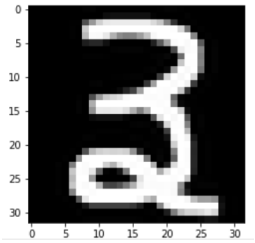

Fig. 10: The Image that was extracted from UI and fed into the model by Allah's permission

VI. Conclusion and Future Work

We are grateful to Allah for making it **very** easy for us to complete the project **and obtain very high accuracy. Had it not for His mercy we would not have been successful in the least**.

In order to make this project beneficial to the public, the CNN model could be loaded into a public server and a cloud-infrastructure could be used to give free cloud-processing to app-developers e.g. handwriting apps for children. Moreover, the model can be used as a foundation to use for multi-digit detection and maybe even automation of answer script marking at primary schools.

References

[1] "Index of /ml/machine-learning-databases/00389."
[2] "rickkk856 / Drawing_App.py."