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Reserch on,"Offline Handwritten Character Recognition Using Machine Learning"

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ABSTRACT—In this paper, a comparative analysis of recent techniques for character recognition is done. Our purpose is to identify the impact of machine learning in the domain of character identification. Character recognition has a lot of applications in the fields of banking, healthcare and other fields for searchability, storability, readability, editability, accessibility, etc. to ease up various processes. Traditional machine learning techniques like a neural network, support vector machine, random forest, etc. have been used as classification techniques. Now with the advancement in the field of computer hardware and efficient research in artificial intelligence field have given emergence to deep learning algorithms. Recent articles are using deep learning for character identification. They also depict how various functions improve the performance in the field of pattern recognition over time. The primary purpose of this paper is to encourage young researchers towards this domain and thus learn and work towards achieving novelty in the field.

Keywords— Handwritten character recognition, Machine learning, Feature extraction, Deep learning.

I.INTRODUCTION

Handwritten recognition is a typical task because there exists a variety of writing ways. Due to the same situation, the computer program does not find good accuracy for the handwritten character recognition task. Literature focuses on English, Bangla, Marathi, Devanagari, Oriya, Chinese, Latin and Arabic languages. Machine learning and deep learning algorithms have been widely used in past literature. At the same time, feature extraction is very crucial. Graph-based features, histograms, mathematical transforms, moment-based features are some popular techniques used for this task. Some necessary steps involved in handwritten character recognition are preprocessing, segmentation, representation, training, identification, and post-processing. As far as practical applications are concerned, a variety of mobile apps and web applications are providing character recognition features to their customers again end user wants better services that can technically be defined in terms of accuracy. Significance and challenges in character recognition are, and our purpose is to explore the solutions available in the past and explore the new possibilities to find out the resolution of the concerned problem. As discussed in the literature, one of the best ways to find the solution lies in the emerging domain of machine learning and deep learning algorithms. With this motivation, we are surveying handwritten character recognition using machine learning techniques. The contribution of this study contains a comparative analysis of various machine learning and deep learning techniques for handwritten character recognition based on various factors like dataset and technique used. The organization of the paper is as follows: Section 2 gives a complete explanation of conventional and recent techniques in machine learning and deep learning field. Section 3 involves a comparative analysis of various techniques for different languages. Section 4 contains conclusion and future work. The section below describes the techniques used for past literature.

II.MACHIENE LEARNING AND DEEP LEARNING TECHNIQUES

Machine learning involves the process of designing a prediction algorithm based on experience. The important part is learning, and it requires data in the concerned domain after that prediction network organizes itself according to error. The current scenario has attained high complexity because the same field has attracted the attention of researchers. Various models are evolving, and some of them are as follows:

1. Decision Trees

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2. Nearest Neighbors
3. Random forest
4. Artificial Neural Network
5. Logistic regression
6. Linear Regression
7. Apriori Algorithm
8. Support Vector Machine
9. K-Means Clustering Algorithm
10. Naive Bayes Classifier
11. Neural Network

Deep Learning has attained pace due to various advancements of hardware and at the same time, algorithmic research that has been done on deep network information processing. Some of the essential algorithms of deep learning are:

a. Recurrent Neural Network
b. Autoencoder
c. Restricted Boltzmann Machine
d. Convolutional Neural Network
e. Deep Belief Network
f. Deep Neural Network
g. Deep Extreme Learning Machine
h. Localized Deep Extreme Learning Machine

III.CHARACTER RECOGNITION SYSYTEM

There is a variety of challenges in the handwritten character recognition system. Process of the handwritten recognition system is shown in Figure1. There are two categories in character recognition: online and offline character recognition. Online character recognition involves a digital pen and tablet. Offline recognition includes handwritten and printed characters. Handwritten characters have a lot of varieties. Segmentation and without segmentation are involved for written words. Further steps involve feature selection(fig1). Optimization can be used to speed up the process of classification. Subsequently, there is a requirement of a classification algorithm for reading features. Finally, a trained model is used for desired tasks.

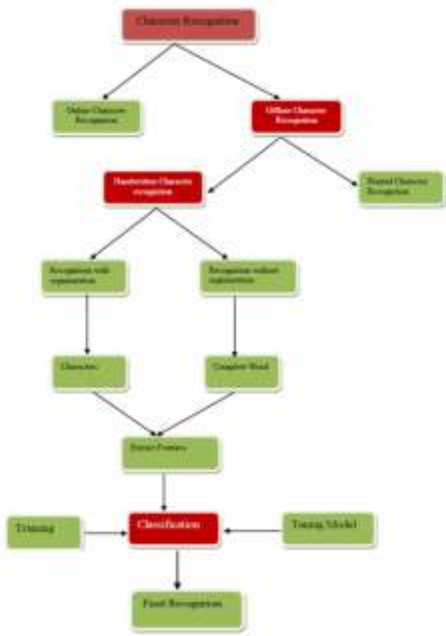

Fig1: Steps involve in feature selection

Machine learning and deep learning plays an important role in computer sciences its paraphernalia and artificial intelligence. Handwritten character recognition is a field of research in artificial intelligence, computer vision, and pattern recognition. A computer performing handwriting recognition is said to be able to acquire and detect characters in paper documents, pictures, touch-screen devices and other sources and convert them into machine-encoded form. Its application is found in optical character recognition, transcription of handwritten documents into digital documents and more advanced intelligent character recognition systems. Developing such a machine needs proper understanding of classification of digits and the difference between the minor and major points to properly differentiate between different digits which can be only possible with proper training and testing Handwritten recognition (HWR) is the ability of a computer to receive and understand intelligible handwritten input from sources such as paper documents, user input touch-screens and other devices. we used Keras and TensorFlow to train a deep neural network to recognize both digits (0-9) and alphabetic characters (A-Z). To train our network to recognize these sets of characters, we utilized the MNIST digits dataset as well as the NIST Special Database 19 (for the A-Z characters). Our model obtained 96% accuracy on the testing set for handwriting recognition.

1. Steps for Character Recognition

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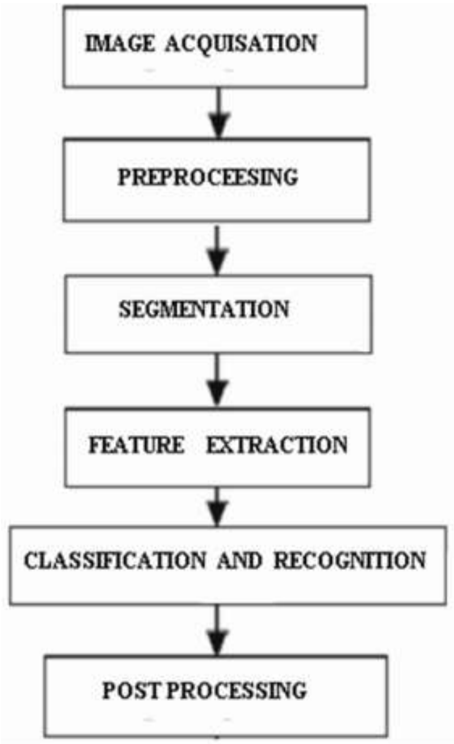

Fig2: Character Recognition Chart

A. Image Acquisition- In Image acquisition, the recognition system acquires a scanned image as an input image. The image should have a specific format such as JPEG, JPG, etc. This image is acquired through a scanner, digital camera or any other suitable digital input device.

B. Pre-Processing- The pre-processing is a series of operations performed on scanned input image. It essentially enhances the image rendering it suitable for segmentation. The role of preprocessing is to segment the interesting pattern from the background. Generally, noise filtering, smoothing and normalization should be done in this step. The preprocessing also defines a compact representation of the pattern. Binarization process converts a gray scale image into a binary image.

C. Segmentation- In the segmentation stage, an image of sequence of characters is decomposed into sub-images of individual character. In the proposed system, the pre-processed input image is segmented into isolated characters and the box can be appread on each of them which letter can be recognized Each individual character is uniformly resized into matrix.

D. Feature Extraction In this stage, the features of the characters that are crucial for classifying them at recognition stage are extracted. This is an important stage as its effective functioning improves the recognition rate and reduces the misclassification. Diagonal feature extraction scheme for recognizing off-line handwritten characters is proposed in this work. Every character image is divided into equal zones, each of size 28*28 matrix and then further priced for recognition.

E. Classification and Recognition- The classification stage is the decision-making part of the recognition system. A feed forward back propagation neural network is used in this work for classifying and recognizing the handwritten characters. The matrix derived from the resized character in the segmentation stage form the input to the classifier. The neural classifier consists of two hidden layers besides an input layer and an output layer.

F. Post- processing -Post-processing stage is the final stage of the proposed recognition system. It prints the corresponding recognized characters in the structured text form by concluding the input image using recognition index of the test samples.

2. Datasets

1.MNIST Dataset(fig3)

MNIST (Modified National Institute of Standards and Technology) consists of samples of handwritten digits, they contain total 70,000 images us of which 60,000 are used in training set and 10,000 are used in testing set, both with appropriately labelled images 10 digits (0 to 9). Handwritten digits are images referring the form 28*28 gray scale intensities of images representing an image with the first column to be labelled as (0 to 9) for every image. Similarly, it has opted for the case of the testing set as 10,000 images with a label of 0 to 9 thus. MNIST is a computer science and vision database consisting of handwritten digits, with labels identifying the digits appropriately, every MNIST data point has two parts: an image of a handwritten digit and its corresponding label. To start with TensorFlow, we will be using the MNIST database to create an image identifying model based on simple feedforward neural network with no hidden layers respectively. The following figure represents the example sample of the MNIST dataset which is to be used using which the system will be trained and then tested for respected output.
There are four files of training and testing are:
Training set images files (train-images-idx3-ubyte)
Training set labels file (train-labels-idx1-ubyte)
Test set images files (t10k-images-idx3-ubyte)
Test set label files (t10k-labels-idx1-ubyte)

2. EMNIST Database

As it can be observed from the previous section, there are a significant amount of works tested

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over MNIST and reporting a test error rate of 1%. For this reason, MNIST is considered to be already solved. As a result, Cohen et al. introduced in April 2017 the Extended MNIST database (EMNIST), consisting on both handwritten digits and letters, and sharing the same structure than the MNIST database. Authors of EMNIST stated that at that point “the dataset labeling can be called into question”, describing MNIST as a non-challenging benchmark.

The source for building EMNIST database was NIST Special Database 19 (NIST SD19), containing NIST’s (National Institute of Standards and Technology of the US) entire corpus of training materials for handprinted document and character recognition, including over 800,000 manually checked and labelled characters from almost 3700 writers who filled a form. Even if this database was available from the mid-1990s, it remained mostly unused due to the difficulty in accessing and using it in modern computers, because of the way it was stored. This was fixed in 2016 when a second version of the database was released with a simpler format.

3.1 Kaggle A-Z dataset(fig3):

The dataset contains 26 folders (A-Z) containing handwritten images in size 2828 pixels, each alphabet in the image is Centre fitted to 2020-pixel box.

Each image is stored as Gray-level

Kernel CSV to Images contains script to convert .CSV file to actual images in .png format in structured folder.

Fig3: MNIST and Kaggle Dataset

VI. CHALLENGES IN AUTOMATIC HANDWRITTEN DIGIT RECOGNITION

1. Challenges in handwritten character recognition Solutions of handwritten character recognition have various limitations.

a.) Error Rate: - As shown in the literature [8-12], various algorithms have been designed to solve the problem of handwritten character recognition, but accurate detection is still a challenging issue.

b.) Detection Speed: - Advance algorithms and deep networks take time in training so to process multiple images, detection time automatically increases.

c.) Scalable Detectors: - Development of scalable detection algorithms that can detect the expanding data properly is a burning issue of handwritten character recognition.

Poor Quality, Poor Inking, and Obsolete Fonts: - As written in the heading, these factors determine the rate of detection accuracy. Proper dataset and its preparation are also a crucial issue. We experimented on various state of the art and other standard methods for Handwritten Digit Recognition. The performance of the methods, namely the Autoencoders and Dense Net models, were recorded on various changing parameters. The best performing activation functions were applied to the network, including Google's new SWISH activation function and ELISH activation function.

Activation Function	Accuracy Autoencoder
Relu	0.9953599962234497
Swish	0.9956799955368042
E-swish	0.9956899953842163
Elish	0.9955199964523316
Selu	0.9951099985122681
Activation Function	***Accuracy DenseNet***
Relu	0.982619
Swish	0980000
E-swish	0.982143
Elish	0.982247
Selu	0.969524

Fig4: Observation for MNIST Dataset

CONCLUSION:

This paper has practiced machine learning techniques including use of TensorFlow to obtain the appropriate digit recognition. Our handwriting recognition system utilized basic computer vision and image processing algorithms (edge detection, contours, and contour filtering) to segment characters from an input image. From there, we passed each individual character through our trained handwriting recognition model to recognize each character.

Our handwriting recognition model performed well, but there were some cases where results could have been improved (ideally with more training data that is representative of the handwriting we want to recognize) — the higher quality the training data, the more accurate we can make our handwriting recognition model. The error rate thus obtained is of 1.25 and training accuracy is 98% and test accuracy 97% demonstrating significant and promising performance. Thus, by practicing this we have achieved success in properly identifying the digits drawn at different angles and properly displaying the correct digit at a single turn. Hence the system would be able to recognize the introduced digit according to the formations made and according to the values in the dataset.

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