Detailed Survey Of Handwriting Recognition Using Machine Learning Algorithms

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Abstract: Handwriting recognition (HWR) or handwritten text recognition (HTR) is the ability of a system (Computer or any computational unit) to receive and interpret handwritten input from input sources such as paper documents, photographs, touch-screens and other devices. The image of the written text may be sensed from a piece of paper by optical scanning (optical character recognition) or intelligent word recognition. Alternatively, the movements of the pen tip maybe sensed example by a pen-based computer screen surface, a generally easier task as there are more clues available. A handwriting recognition system handles formatting, performs correct segmentation into characters, and finds the most plausible words. There have been many handwriting recognition systems available in the market.

Keywords- Hand written, machine learning, recognition

1. Introduction

Hand written character recognition can be done via online or offline which are differentiated via implementation mechanism. In offline system, static representation of a digitized document is used in applications such as check, form, mail or document processing. Offline handwritten character recognition is one of the practical important issues in pattern recognition applications. Digit recognition is an important component of handwritten character recognition system due to its wide application. From more than three decades can achieve high classification high recognition rates in the area of recognition of hand written numerals. Handwriting recognition systems convert handwritten text into machine readable form and work either on offline images (scanned or camera based) or on writing captured directly on a digitizing device (online recognition). From the view point of recognition systems for cursive Text (like Arabic, Urdu, and Persian etc.), recognition of Arabic handwriting has been investigated in a number of studies. A key factor responsible for this enormous increase is the availability of low-cost smart phones equipped with cameras. With such huge collections of data, there is a need to have efficient as well as effective retrieval techniques allowing users retrieve the desired content. Traditionally, videos are mostly stored with user assigned annotations or keywords which are called tags. When content is to be searched, a key word provided as query is matched with these tags to retrieve the relevant content. Characters, and digits help people to solve more complex tasks that otherwise would be time-consuming and costly. A good example is the use of automatic processing systems used in banks to process bank cheques. Without automated bank cheques processing systems, the bank would be required to employ many employees who may not be as efficient as the computerized processing system.

A neural network is the most appropriate for the proposed system due to its ability to derive meaning from complex data and detect trends from data that are not easy to identify by either other human techniques or human. The text recognition area has a very large scope. Hand writing recognition and typewriter /computer writing recognition are subfields of the hand writing recognition area. Computer or typewriter recognition field can produce faster and more accurate results. Unlike handwriting recognition; it is expected to see higher success rates as there are no characteristic patterns and lines in letters or digits, such as spaces between letter sand words. Handwritten Digit Recognition is a very widely searched topic within the sectors or fields which are concerned about the learning model to differentiate pre-segmented handwritten digits. Also, it is the most important problem in ML, pattern analysis, data mining and AI. The uses of these machine learning methods are competing with the accuracy and decision taking performance of humans.

2. LITERATURE SURVEY

The paper titled Hybrid neural models for automatic handwritten digits recognition uses a novel Handwritten Character Identification methodology that performs the recognition of the students' identification numbers handwritten in classroom maps has beenproposed. A dataset of 60.0000 handwritten training images of the MNIST dataset and appropriate dataset composed of 3.415 images extracted from 12 classroom maps handwrittenby 11 different persons is used in this work. These images were obtained through thesegmentation process described in this work, and had suffer some image processing beforefeature extraction and classification in order to be as similar as possible to the MNIST dataset samples. The algorithm is composed by four main steps: Pre-processing, Segmentation, Feature extraction, and Classification. As a conclusion from the performance of the classifiers receiving HOG features and/or features from the fully-connected layer of the CNN, CNN provides a better diversity of features than the features extracted by HOG. It is clear that the main issue in the segmentation process is the sloppiness on the writing of some numerals, the placement of the numbers on unexpected regions and the image resolution.

The paper titled Comparative Study on Handwritten Digit Recognition Classifier Using CNN and Machine Learning Algorithms are discussed with respect to approach and the outcome of the work. Numerous technologies and different systems have already been tried and tested on this handwritten digit recognition, but the recognition accuracy is too low to be deployed. To resolve these issues, three different machine learning techniques were used to solve this problem and create a model that could recognize handwritten digits with better accuracy. Three major algorithms were "Convolutional Neural Network (CNN), K Nearest Neighbour (KNN), and Support Vector Machine (SVM)" in which the results showed that the "Convolution Neural Network (CNN)" performed the best for image recognition tasks. Convolution networks perceive pictures as an it that consumes 3D space that implies three dimensional articles. This paper concludes that different classifiers can affect the recognition rate for handwrittendigit recognition. The presented results depict that CNN is the bestclassifier for handwritten digit recognition. Convolution neural networks used ina project achieved an accuracy of 99.59% on using the holdout validation technique forreducing overfitting and using the batch size of a hundred. In future, proposed system can beupgraded and used for other datasets and classification of handwritten alphabets.

The paper titled Real time handwritten digit recognition have built a handwritten digit recognition GUI app in python usingMachine Learning. They have trained their model to recognise the digits 0-9.The process takes place in the following steps: Collection of samples, Pre processing, Feature extraction, Classification, Training images, Evaluation and verification. The data set they have provided is self-created, which is done by using the basic paint tool. For data processing they have used OpenCV, Numpy, Pandas, Sklearn. The model has successfully recognised the digit that has been provided. They havebuilt a GUI app in python based on machine learning.

The paper titled Handwritten character recognition using deep learning in android phones have developed an android model to recognize the handwritten character. They have made use of deep learning, an Artificial intelligence is used for system to learnthe input automatically and convert the handwritten text to printed text. In this model the userhas to create a user name and password and then upload the image which contains thecharacters to recognize. This application also converts the printed text into speech.There are a total of 4, 00,000 images and 30,000 are used for training. The Kaggle dataset for handwriting recognition is used in this model.The model has been divided into 2 parts – front end for which flutter is used. Flutter is anopen source GUI software development it created by google, back end- for which OpenCV, keras, tensor flow lite, Google text-to-speech and firebase are used.

The paper titled Cursive Handwritten Text Recognition using Bi-Directional LSTMs: A case study on Urdu Handwriting presents a recognition system for handwritten Urdu text. Machine learningfeatures are extracted from these text lines using convolution neural network (CNN) andfeature sequence are classified using a bi-directional long-short term memory (LSTM)network.The dataset contains 6000 unique text lines from 600 writers. 4000 have been used astraining data set, 1000 as validation set and the remaining as testing data set.Here, raw pixel values from columns of text lines are fed to a 1-D LSTM for learningand classification except the raw pixel values are replaced by the features extracted byCNN. The combination of CNN and LSTM, a type of recurrent network, is used for thistask.The network architecture consists of seven convolution layer followed by two B-LSTMlayers. Pooling, batch normalization land drop out later are also added. First the input handwritten image is binarized as a pre-processing step and given toconvolution layer. Then the output from the convolution layer is fed to recurrent neuralnetwork , LSTM which is followed by a CTC layer (Connectionist temporal classification(CTC) is a type of neural network output and associated scoring function, for training recurrentneural networks (RNNs) such as LSTM networks to tackle sequence problems where the timing is variable). The system gives an accuracy of 83.69% on 1000 test lines. In most cases the ground truthand the predicted characters have similar shapes and in some cases the main body of the characteris correctly identified but the wrong number of dots lead to recognition errors.The characterrecognition rates are computed by calculating Lavensthein distance between ground truth and the predicted transcription. Levensthein distance: The Levenshtein distance between two words is the minimum number ofsingle-character edits (insertions, deletions or substitutions) required to change one word into theother.

The paper titled Handwriting Recognition using Artificial Intelligence Neural Network and Image Processing uses Neural networks for handwriting recognition are more efficient and robust compared to other computingtechniques.The dataset is taken from university students and professors who require electronic form of the handwrittennotes and documents.The deep neural network memorises the training data to be able to recognize handwriting. Hence, this method isused for optical character recognition systems. The current system used neural networks to process and read handwriting characters and digits. The system benefited from Convolution Neural Networks (CNN) with the help of training data that allowed easy Recognition of characters and digits. The phases of handwriting recognition included image acquisition, digitization, pre-processing, segmentation, feature extraction, and recognition.

The paper Online Handwriting Recognition using Support Vector Machine uses Neural network and Hidden Markov Model are two popular methods for handwriting recognition system. Support Vector Machine is an alternative to Neural Network and also gives a better recognition result. The advantage of SVM, is that it takes into account both experimental data and structural behaviour for better generalization capability based on the principle of structural risk minimization (SRM). In all the experiments, the results have shown that at character level, SVM recognition rates are significantly better due to structural risk minimization implemented by maximizing margin of separation in the decision function. Multidimensional feature vector. The number of support vectors can be reduced by selecting better C and gamma parameter values through a finer grid search and by reduced set selection

The paper Handwritten Digit Recognition Using K-Nearest Neighbour Classifier uses MNIST (Modified NIST) database which includes a training set of 60,000 images and a test set of 5000 images. The MNIST digit database is good database for applying learning techniques and patterns recognition methods because of this database need less time for noise removal in pre- processing. In this paper uses a set of 25000 images from (Special Database) SD-3 and 25000 images from SD-7 for training set and a set of 2500 images from SD-3, 2500 images from SD-7 for test set. The training set and test set were disjoint sets. The figure 1 shows the samples of the numerals of MNIST database. After convert theg images into binary, these images may have surplus elements one's (black) at undesirable places in the background image is called noise. It is necessary to remove noise from the image. To remove these unwanted one's from the background, need an algorithm. In this algorithm 3X3 template is used. By top reservoirs of a digit, it means the reservoirs obtained when water is poured from top of the digit. The water reservoir area is appeared when digit image is unconnected. The figure 2 shows Top reservoir area of the Digit 4. If digits are unconnected then the cavity regions are generated. The same methodology is used for bottom reservoir, left reservoir and right reservoir. The overall classification design of the MNIST digit database is shown in following algorithm. In any recognition process, the important problem is to address the feature extraction and correct classification approaches. The proposed algorithm tries to address both the factors and well in terms of accuracy and time complexity. The Overall accuracy of 96.94% is achieved in the recognition process.

The paper Hand written Digital Classifier have built a handwritten digit recognition using Machine Learning. Only one data set was used for the study. The working conditions of the algorithms can be examined by performing tests on different data sets. Such as Source Vector Machine, Decision Tree, Random Forest, ANN, KNN, K-means algorithm. In this study, MNIST data set was used for the training and tests of the system. MNIST database is widely used internationally. It consists of handwritten numbers. The MNIST database contains 60,000 training data and 10,000 test data. The black and white images from MNIST were normalized to fit into a 28x28 pixel bounding box and anti-aliased, which introduced grayscale levels all the tests within the scope of the study were performed on the pycharm.

The paper Recognition of Handwritten Digit using Convolutional Neural Network in Python with Tensor flow and Comparison of Performance for Various Hidden Layers is to observe the variation of accuracies of CNN to classify handwritten digits using various numbers of hidden layers and epochs and to make the comparison between the accuracies. For this performance evaluation of CNN, we performed our experiment using Modified National Institute of Standards and Technology (MNIST) dataset. Further, the network is trained using stochastic gradient descent and the back propagation algorithm. In this paper, the variations of accuracies for handwritten digit were observed for 15 epochs by varying the hidden layers. The accuracy curves were generated for the six cases for the different parameter using CNN MNIST digit dataset.

3. TOOLS

- Python programming higher installed in windows 10 or any distribution of Linux.
- Arduino IDE software
- Training of an ANN model using Coding Source in MATLAB.
- Python open source library called TensorFlow1 is used in order to train the neural network.

4. APPLICATIONS

- National ID number recognition system
- Postal office automation with code number recognition on Envelope
- Automatic license plate recognition
- Bank automation.

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