

A NOVEL METHOD FOR HANDWRITTEN DIGIT RECOGNITION SYSTEM

Introduction:

Handwriting recognition is one of the compelling research works going on because every individual in this world has their own style of writing. It is the capability of the computer to identify and understand handwritten digits or characters automatically because of the progress in the field of science and technology, everything is being digitalized to reduce human effort. Hence, there comes a need for handwritten digit recognition in many real-time applications. MNIST data set is widely used for this recognition process and it has 70000 handwritten digits. We use Artificial neural networks to train these images and build a deep learning model. Web application is created where the user can upload an image of a handwritten digit. This image is analyzed by the model and the detected result is returned on to UI.

Literature Review

[1] Character recognition plays an important role in the modern world. It can solve more complex problems and makes human's job easier. An example is handwritten character recognition. This is a system widely used in the world to recognize zip code or postal code for mail sorting. There are different techniques that can be used to recognize handwritten characters.

Author : MALOTHU NAGU, N VIJAY SHANKAR, K. ANNAPURNA

Keywords : Pattern recognition, neural network, handwritten characters

Advantages : Using Neural Network System, Back-Propagation learning, To recognize handwritten digits was very successful.

Disadvantages : The part will also need more improvements. Apart from the above problems and parts that need improvements, The overall recognition system was successful .

[2] In the area of pattern recognition and pattern matching the methods based on deep learning models have recently attracted several researchers by achieving magnificent performance. In the use of the convolutional neural network to recognize the multifold offline Urdu handwritten characters in an unconstrained environment.

Author : Mujtaba Husnain Malik Muhammad Saad Missen Shahzad Mumtaz Muhammad Zeeshan Jhanidr Mickaël Coustaty Muhammad Muzzamil Luqman Jean-Marc Ogier and Gyu Sang Choi

Keywords : Offline Urdu handwriting; Urdu handwriting recognition; convolutional neural network

Advantages : In this paper, we made use of CNN (convolutional neural network) in recognizing and classifying Urdu handwritten characters. We also generated a novel dataset of Urdu handwritten characters and numerals.

Disadvantages : Proposed model was quite efficient (in terms of accuracy) and effective at performing the recognition and classification since it provided better accuracy in the minimum time as compared with the others, and it is suitable for developing a learning application for children on mobile phones.

[3] Handwritten Digit Recognition has a wide variety of applications in postal mail order, phone records search, automatic car number plate recognition, and in the medical sector that observed how Machine Learning makes the daily tasks simpler and more efficient.

Author : Aman Arora, Omar Hisham Alsadoon, Teaba Wala Aldeen Khairi, Tarik A. Rashid
Keywords : Handwritten Digits Recognition, Optical Digits Recognition, SVM, CNN, Deep Neural Network, Bayesian Classifier.

Advantages : This research has led to an increase in the Classification Accuracy of Handwritten Digits under the Evaluation Phase using Root Mean Square Error (RMSE) as the comparison error.

Disadvantages : The Histogram of Oriented Gradient (HOG) can be employed for feature extraction due to its efficient results in the handwritten recognition field.

[4] Unconstrained handwriting text recognition is a stimulating field in the branch of pattern recognition. This field is still an open search due to the wide variability of human writing. Recent trends show a potential improvement of recognition by adoption a novel representation of extracted features.

Author : Najoua Rahal, Maroua Tounsi, Tarek M. Hamdani and Adel M. Alimi

Keywords : Handwriting text recognition; Bag of Features; Deep Sparse Auto-Encoder; Features Learning; Hidden Markov Models;

Advantage : Handwritten words and digits recognition using Deep SAE based BoF is introduced in this work at the dictionary learning phase for an efficient feature extraction.

Disadvantage : The Deep SAE BoF representations must be adaptable to a variety of problem fields as well. Moreover, more powerful strategies could be considered to integrate more robust features.

[5] Although Bayesian inference enhances intelligent probabilistic computing systems, it is computationally expensive and not efficient to implement on traditional von Neumann

architectures. In this paper we propose a simple and novel way to implement approximate Bayesian inference that relies on the Naive Bayes Nearest Neighbour (NBNN) algorithm using memristors

Author : Mohammad M.A. Taha and Christof Teuscher

Advantage : We proposed a simple, novel, and low-power memristive hardware implementation for the NBNN while incorporating variable priors.

Disadvantage : Our work is relevant for object recognition applications that require high speed and/or low power and can tolerate a slight loss in accuracy.

[6] We describe a novel spiking neural network (SNN) for automated, real-time handwritten digit classification and its implementation on a GP-GPU platform. Information processing within the network, from feature extraction to classification is implemented by mimicking the basic aspects of neuronal spike initiation and propagation in the brain.

Authors : Shruti R. Kulkarni, John M. Alexiades, Bipin Rajendran

Keywords : Spiking neural networks, classification, supervised learning, GPU based acceleration, real-time processing

Advantage : We developed a simple three-layer spiking neural network that performs spike encoding, feature extraction, and classification.

Disadvantage : Using this GPU implementation, we demonstrated a touch-screen based platform for real-time classification of user-generated images.

[7] With the invention of the Microsoft Kinect sensor, human-computer interaction is gaining its attention and becoming available for widespread use. The previous study presented a method of Kinect-based mid-air handwritten digit recognition for Android smartphones.

Author : Chiang Wang, Chung-Yen Su, Chun-Lin Lin

Keywords : Kinect sensor; human-computer interaction; handwritten digit recognition; accuracy rate; support vector machine

Advantage : It can provide a more efficient method in comparison with the previous

Disadvantage : Recognize digits written in the air only.

[8] In recent years, many deep architectures have been proposed for handwritten text recognition. However, most of the previous deep models need large scale training data and a long training time to obtain good results.

Author : Yuchen Zhengt, Yajuan Cait, Guoqiang Zhongt, Youssouf Chherawala, Yaxin Shit and Junyu Dongt

Keywords : Text recognition; feature learning; deep learning; deep architectures; stretching.

Advantage : Extensive experiments on handwritten digits recognition, Arabic subword

recognition and English letter recognition demonstrate that SDA outperforms not only traditional feature learning models, but also state-of-the-art deep neural network models.

Disadvantage : For future work, we plan to adopt some other techniques to enhance SDA, such as dropout and supervised finetuning.

References:

- [1] Y. LeCun, Bag-of-words image representation: Key ideas and further insight. Fusion in Computer Vision, pp. 29-52, 2014.
- [2] S. O'Hara and B. A. Draper, Introduction to the Bag of Features Paradigm for Image Classification and Retrieval. arXiv Prepr.arXiv1101.3354, 2011.
- [3] G.Csurka,R.Dance, Christopher,L.Fan,J.Willamowski and C.Bray, Visual categorization with bags of keypoints. Workshop on statistical learning in computer vision, pp. 1-22, 2004.
- [4] S. Fiel and R. Sablatnig, Writer Identification and Writer Retrieval Using the Fisher Vector on Visual Vocabularies. 12th International Conference on Document Analysis and Recognition, 2013.
- [5] L. Rothacker and G. A. Fink, Segmentation-free query-by-string word spotting with bag-of-features hmms.International Conference on Document Analysis and Recognition, 2015.
- [6] Assayony, O. Mohammed and S. A. Mahmoud, Recognition of Arabic Handwritten Words using Gabor-based Bag-of-Features Framework. International Journal of Computing and Digital Systems, 2018.
- [7] Assayony, O. Mohammed and S. A. Mahmoud, An Enhanced Bag-of-Features Framework for Arabic Handwritten Sub-words and Digits Recognition. Journal of Pattern Recognition and Intelligent Systems, 2016.
- [8] L. Rothacker and G. A. Fink, Robust Output Modeling in Bag-of-Features HMMs for Handwriting Recognition. International Conference on Frontiers in Handwriting Recognition, 2016.
- [9] P. Vincent, H. Larochelle, I. La-jolie, Y Bengio and P.A.Manzagol, Stacked Denoising Autoencoders: Learning Useful Representations in a Deep Network with a Local Denoising Criterion. Journal of Machine Learning Research 11, 2010.
- [10] H. E. Mubtaahij, A. Halli and K. Satori, Using Features of Local Densities, Statistics and HMM Toolkit (HTK) for Offline Arabic Handwriting Text Recognition. International Journal of Electrical Systems and Information Technology, 2017.
- [11] M. Rabi and M. Amrouch, Recognition of Cursive Arabic Handwritten Text Using Embedded Training Based on Hidden Markov Models. International Journal of Pattern

Recognition and Artificial Intelligence, 2018.

[12] L. Rothacker, S. Vajda and G. A. Fink, Bag-of-Features Representations for Offline Handwriting Recognition Applied to Arabic Script. International Conference on Frontiers in Handwriting Recognition, 2012.

[13] L. Rothacker and G. A. Fink, Robust Output Modeling in Bag-of-Features HMMs for Handwriting Recognition. International Conference on Frontiers in Handwriting Recognition, 2016.

[14] N. Rahal, M. Tounsi, A.M. Alimi, Auto-Encoder-BoF/HMM System for Arabic Text Recognition. arXiv preprint arXiv:1812.03680, 2018.

[15] D. G. Lowe, Distinctive image features from scale-invariant keypoints. International Journal of Computer Vision, 2004.

[16] G.E. Hinton and R.R. Salakhutdinov, Reducing the dimension-ality of data with neural networks. Science, 2006.