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Research Article

Handwritten Digit Recognition from Image Using Confusion Matrix

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ABSTRACT

Recently, the creation of numerous machine learning, deep learning and computer vision algorithms has rendered hand- written visual identification by researchers highly important. I compare the results of some of the most used algorithms such as SVM , KNN & RFC, and CNN. In this article. CNN using Theano and Tensorflow for Keras. With these, I was able to reach 99.6% precision with CNN (Keras+Theano), opposed to 98.00% with SVM, 98.22% with KNN, and 97.77% with RFC.

Keyword: Machine Learning , Deep Learning, Computer Vision Algorithms, SVM , KNN & RFC, and CNN.

1. INTRODUCTION

In India, at present where computer technologies and artificial intelligence is booming widely all around the globe, the role of deep learning and machine learning in recognizing the hand written digits has become very important. This is nothing but the ability of a machine to understand a hand written digit and then to classify it. In order to develop such machine learning systems, it is important for the machine being able to understand and then group the hand-written numbers from 0 to 9 into 10 separate ones. The goal is to recognise handwritten numbers from various sources such as documents, photographs, e -mails, etc. Many machine learning algorithms and models have been developed for this reason in the past. Algorithms are used, including neighbors from K-Nearest, vector support tools, CNN and Random Wood.

But those processes, while 97 percent precision, are not adequate for applications in the modern world.In an earlier decade, significant learning has become thehot instrument. A lot of AI gadgets have been rendered including scikit-learn scipy-picture and pybrains, Keras, Theano, Tensorflow by Google and TFLeam. These mechanical assemblies make the applications incredible and thusly progressively exact. The Artificial Neural Networks with all the intents and purposes reflect the human cerebrum. These developments are used to develop such a model with extraordinary exactness to see a request composed by the hand digits.

2. LITERATURE SURVEY

"**Handwritten digit identification focused on multilayer perceptron performance autonomous**"With translated digit affirmation being developed and gigantic issue that is standing up to PC vision and model affirmation, there has been a ton of investigation work that has been around there. lt's definitely not an irrelevant task because of the gigantic assortment that occurs in the development of styles contained in open data. Therefore both the characteristics and the classifier should be able. Another representation method focused on the MLP that can be recognised is the interior responsibility of this investigation.

Physically composed reports as combined. The numbers '0' and '1' are used. This strategy maps the different course of action of various data on the neurons generated by MLP. An exploratory evaluation of the presentation of the strategy is given. This evaluation is focused on a groundbreaking 'Pen-based handwritten digital dataset' which contains a total of 250 handwriting assessments from 44 writers. The findings are incredibly promising for an exact handwriting technique affirmation.

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"**Bangla text document categorization mistreatment 2007**" Vol.7, 1Regardless, there's an overwhelming pointlessness of various neural framework methods that are utilized in the composition. This paper depicts a social occasion of strong recommended strategies that report examination experts who use to induce sensible results with neural frameworks. The principal basic watch is securing an educating set as beast as could sensibly be normal: we will all in all develop the readiness set by things up of contorted data. The subsequent most basic watch is that convolutional neural frameworks are higher fitted to visual chronicle assignments than totally related

This paper describes the Bangla Document Categorization misuse stochastic Gradient Descent (SGD) classifier. Here, record classification is that the endeavor inside which text reports are requested into one or a huge amount of predefined classes reinforced their substance.

The seen system will be divided into 3 phases: 1. Feature extraction joining term frequency (TF) and inverse document frequency (IDF), 2. Classifier style misuse the SGD algorithm, and 3. Execution measured using F1-score. Inside the examinations on BDNews24 reports, it's discovered that our foreseen framework outfits higher vision differentiated and the methods maintained Support Vector Machine (SVM) and Naive Bayesian (NB) classifier.

"**Good practices for the creation of neural networks related to the study of visual records**."Neural frameworks are a strong development for request of visual information sources. We will then all is said in done recommend that a direct do-it-yourself execution of convolution with an adaptable arrangement is fitting for visual document issues. This straightforward convolutional neural framework doesn't require tangled strategies like power, weight decay, structure-dependent learning rates, averaging layers, straying prop or possibly finely-tuning the arrangement. The top result's an incredibly immediate in any case wide arrangement which may yield dynamic execution for file examination. We will by and large layout our cases on the MNIST set of English digits.

"**At liberty written Mistreatment empirical identification plurality election classifier**."Unconstrained detached made numeral affirmation may be a problematic inconvenience it's horribly difficult to peer out high affirmation Tests for one classifier. This article has an instant profile, joined nearby & global other options and bigger part balloting subject classifier.

At opportunities made numeral affirmation. The straightforward profile function is prepared by misusing the left, right, top and bottom profile of an image. By connecting all profiles, a segment vector of 112 duration is generated. The surrounding vector is extracted by reconstructing Daubechies on the four photos produced by applying the cognac boss. The ultimate choices are made in this respect by applying the slightly shifting edge upgrade to the fundamental frame. An eighty-part vector is rendered by uniting 64 neighbor's decisions and 16 worldwide decisions. The part vectors are the ability of a strip inside the soy portion of an image on the third stage. Four neural network classifiers are used for this evaluation: multilayer feed, pattern confirmation, forward cascade, suit neural frame classifiers, and 2 math classifiers: discriminating linear inspection and classifiers for KNN are used. A big trend of voting was carried out for 3 classifications of neural systems and KNN. The neural network was educated on 60,000 and 10,000 numeral samples were tested.

3. EXISTING SYSTEM

The MNIST dataset is a collection of 70,000 digits, divided into 60,000 ready-to-use versions and ten thousand checks. The images in the MNIST dataset can be used as a view 28x28 characteristics addressing an image nearby their imprints.

4. PROPOSED SYSTEM

For the purpose of hand written digits recognition there exists various systems using various algorithms. There are systems which make use of SVM algorithm, Random Forest Algorithm, KNN algorithm, CNN etc. to recognize the hand written digits. These algorithms have shown accuracy between 85-95% which is not really sufficient.

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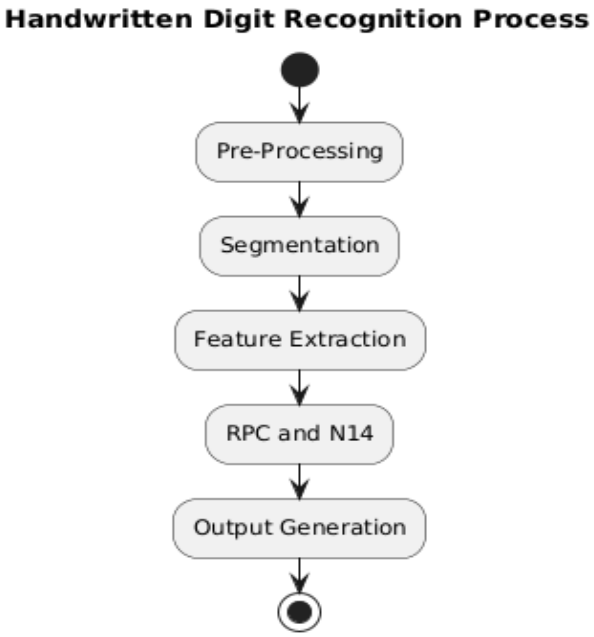

Fig. 1: Block diagram of Handwritten Digit Recognition

4.1 TERMINOLOGIES

4.1.1MNIST Dataset:

The MNIST dataset is part of a broader NIST dataset. This is a collection with about 70,000 numerical figures, limited to 60,000 and 10,000 check sets. The images in the MNIST dataset are of a sort of presentation with 28x28 characteristics presenting a close up shot of their imprints.

The pixels exist as an assortment of 784-d pixels and the characteristics run from 0 to 255 — for instance, 0 means Black and 255 means White.

MNIST Dataset Format Analysis:

The MNIST data is given in a specific style. This is a profound interaction with the data current to analyze the data collection. The two basic pages, called the "Magic Number" and the number of items, include all the preparation and learning photos and titles.

4.1.2 Algorithm

1. Load MNIST the dataset.
2. Label the information as training and testing set.
3. Train the classifier utilizing Random Forest algorithm.
4. Then fit the Random Forest model with the information.
5. Total check number (digit) recognition is finished.
6. Confusion matrix displayed.
7. Finally predict output.

4.1.3 CNN

I use the multi-layer Deep Convolutional Neural Network [CNN] for digit validation. I used Keras and Tensorflow to demonstrate the Deep Neural Network's working accuracy. A Convolutional Neural Network (CNN) is also an

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artificial neural feedforward network, in which the interaction of animal visual cortex determines the connectivity mechanism of its neurons. Neural networks include neurons with weights and biases. Each neuron receives some information, applies a function, and reveals a non-linearity.

Accuracy comparison of KNN, SVM, RFC and CNN algorithms:

Algorithm	Accuracy
KNN	98.22%
SVM	98.00%
RFC	97.77%
CNN	99.6%

5. RESULT AND ANALYSIS

In this paper, the results using the above techniques are shown.

FIG1:II ninepage

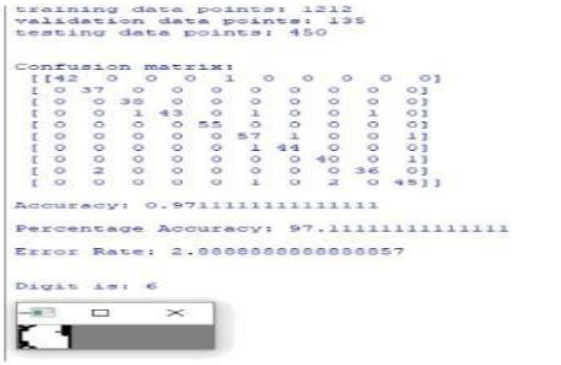

FIG3:RFCresult.

FIG2:KNNresults.

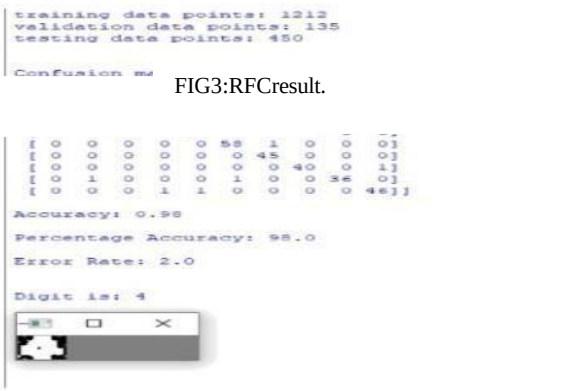

FIG4:SVM result.

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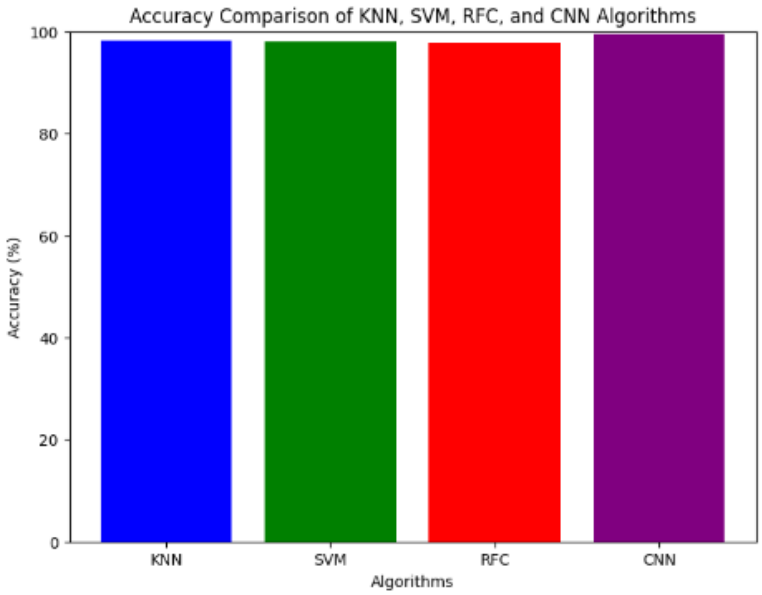

Fig 6: Overall graph

6. CONCLUSION

The Convolutional Neural Network model was compared with models such as SVM, KNN and RFC. Thus, we can conclude that neural networks gave better result precision when compared with other algorithms. The accuracy of CNN reached 99.6%. Also, utilization of CNN using Tensorflow gives a far better result of 99.70%. Each model has its own complexity and precision. Although the complexity of the code and method is higher compared to traditional Machine Learning algorithms, considering the achieved accuracy, it can be said that it is justified. Moreover, the current execution is done simply using the CPU, so it is possible to achieve much more parallelism and better results.

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