A Novel Interpolation Perspective for Handwritten Digit Recognition using Neural Network

Shruti Pandey, Siva Shanmugam G

Abstract: ***In this work, we present an innovative technique for manually written character recognition that is disconnected, using deep neural networks. Since of the accessibility of enormous knowledge calculation and numerous algorithmic advances that are emerging, it has become easier in this day and age to train deep neural systems. And seeks to classify the numerical digits so that digits can be translated into pixels. Today, the computing force measure required to prepare a neural system has increased owing to the proliferation of GPUs and other cloud-based administrations like Google and Amazon offer tools to prepare a cloud-based neural system. We also developed a system for the recognition of character dependent on manually written image division. This project uses libraries such as NumPy, pandas, sklearn, seaborn to accomplish this either by linear and non-linear algorithm, to know its precision on confusion matrix and accuracy. This idea spins with RBF(radial basis function) which consists of two parameters as C and Gamma and classifying the pixel digits. To train those models, research work includes Convolutional Neural Network (CNN), Dynamic Neural Network(DNN), Recurrent Neural Network(RNN), and TensorFlow algorithms using Keras , which can be accurately used for the classification of the digits.***

Keywords: Digit recognizer, Numerical Digits, Pixel Format, Handwritten Recognition

I. INTRODUCTION

Recognition is the acknowledgment of the existence of knowledge. Likewise, Digit Recognizer is recognizing and identify the numerical digits. It is a framework for the working of the machine to interpret the numerical digits. Machine Learning provides methods through human efforts, which helps in recognizing the manually written digits. Deep Learning is a part of the machine learning method which will train to do what easily falls into place for people such as learning through examples. With the utilization and development of deep learning methodology, the human attempt can be used as a diminished in perceiving, learning,recognizing, and in various regions.

[1]Handwritten Recognition in the MNIST dataset known among scientists by utilizing the different types of classifiers, the error rate is decreased, for example, from the linear classifier (known as1-layer NN) by 12% to 0.23% by 35 convolution neural systems. The scope is to implement the Handwritten Digit Recognition framework about the heterogeneous classifiers and a variety of techniques to accomplish it, which is close to human performance.

Revised Manuscript Received on June 22, 2020.

***** Correspondence Author

Shruti Pandey*, School of computer science and Engineering, Vellore Institute of Technology Vellore, India. E-mail: shruti.pandey2018@vitstudent.ac.in

Siva Shanmugham G, School of computer science and Engineering, Vellore institute of technology Vellore India. E-mail: sivashanmugam.g@vit.ac.in

For composing different digits (0-9). [2] In the 21st handwritten numerical digit has its standard and used in daily life, which is used as means of conversation, the challenges of the handwritten numerical recognition lie in variation and distortion of handwritten digit set because of using different ways of handwriting. [3] The handwritten numerical digit dataset is vague because as there must be sharp and perfectly straight lines. The main goal in numerical recognition is feature extraction, which helps to remove the redundancy of the data, and it gains a lot from the image through a set of numerical attributes. It deals with the extraction of most of the essential information through image raw data. According to an efficient handwritten digit recognition system which can be used to develop by considering the above limitations. Sometimes it is difficult to identify its own handwritten numerical.

II. RELATED WORK

The research work requires more knowledge on the proposed idea, because of accuracy matters. So we considered several years of research happened in the history and those notch points are related in this section.

The paper[3], the process for the offline identification of the handwritten numerical digits with the use of Hidden Markov models (HMMs) has been. With the help of Naive Bayes, classifier presentation produces the outcome in the form of the HMM algorithm, with the development by disregard the reaction of inter-word adjustment while trying the Viterbi algorithm to return character sequence. Finally, it is contrasted to the dictionary creation and the lookup algorithm, i.e., applicable for the general dataset to achieve the particular outcome.

The high-level function of this paper is to classify the different range of images, and the problem is that image of text has been distributed into images of the different characters. Therefore, the data is validated into cross-validation folds.

The author [3] implies real-life document identification systems that represent the collection of multiple sections, including field extraction partitioning and language pattern. This paper consists of a learning model called Graph Transformer Networks GTN, which allows a multi-module system that will be trained globally using the Gradient-Based method, which will help us to minimize an execution.

In this work [5][6], Multi-Layer neural networks are being trained through the backpropagation method for document recognition. Thus, it can be used for synthesizing the complex decision to classify into a high dimensional pattern with pre-processing. Thus, documents are being composed of different modules, which will include field-extraction, segmentation, and language modeling.

Here [9], includes a new learning paradigm, such as Graph Transformer Networks (GTN), which will minimize performance. This paper is better for the recognition that can be built on automatic machine learning, and also teaches us the complex high-dimensional non-linear mappings from large collections of examples, which makes them better for image recognition tasks.

The work [11] inspired by the different models which are used for speech recognition, image inscription, or translation. The main difference is the implementation of the covert and overt attention with a multi-dimensional LSTM network. This paper [10] has the major benefaction towards handwritten identification, which lies in transcription without segmentation—deep convolutional neural networks (CNN) with a series of improvement of the image classification. Deep networks naturally integrate the low/mid/high-level features and classifiers into an end-to-end multi-layer pattern and "levels" of the various features which will enhance the number of the layers (depth). In this paper, the input is a variable of two dimensional(2 D) image, and the result will be a sequence of different characters. The cursive character in this paper will make it hard for the first segment to identify it, thus development in deep learning and the new architectures, which will allow building systems that will handle both the 2D aspect of the input and the sequential aspect of prediction.

In this [2], the current systems will divide the text lines, which will be available in real-world applications. The complete processed pipeline is a must which relies on automatic line prediction algorithms to transcribe a document. The similarities in the application are with the image caption and speech recognition. This paper aims to select the important parts of data signal into sequential generated -text., the paper data are images which will be similar to the speech recognition, predicting that the long sequence of characters.

The majority of work in [7] consists of deep neural networks that are burdensome for getting trained, which will present a learning structure to train the networks. Deep convolutional neural networks [DNN] have led to a series of image classification. Deep networks have been integrated with the low/mid/high-level feature and classifier into end-to-end, the "levels" of this feature, which will be enriched with the no of layers (depth). The deep networks in this paper can start converging, which will cause a mortification problem: with the network keeps on increasing, the accuracy gets saturated, and then it will start to degrade it fast. The breakdown is not only the cause by over-fitting and adding many layers to the model, which leads to the higher training error, which will indicate that the systems are not similar and easy to optimize. Finally in [3][11], the architecture is deeper, which will add many layers and helpful to our proposed work on desiring the characterisitics. Thus, there will be a solution by building the model deep: therefore, the added layers in this paper have been mapped with the identity, and another layer will be copied from the shallow model. The existence of the solution in this paper will indicate that the model should get no high train error.

III. PROPOSED ARCHITECTURE

This project converts or translates the numerical digits into pixel format, which will be used in this project. Firstly, in this project the libraries will be used, such as NumPy, pandas,matplotlib, seaborn and after importing of the libraries there will be reading the test data as well as the training data and then visualizing the no. of class and counts the dataset in the form of graph-columns, while visualizing the train data in the form of a graph, reshaping the digits and presenting it accordingly. Then, using the linear model as well as the non-linear model to get its confusion-matrix and accuracy of the model, whichever gets the highest accuracy which is a linear model and then using the RBF(radial basis function) which consists of two parameters as C and Gamma. While using the Gamma Function, if the value will be low, it means the value will be far. When the value is high it describes it as close, In C the larger value accepts smaller margin and the lower value is described as the high margin, using the K-fold which divide it into k parts, Firstly it will be split into the dataset into k-groups then take it as the group of the test data and the left groups as a training data set and then getting the cross-validation results. Using Convolutional Neural Network (CNN), Dynamic Neural Network(DNN), Recurrent Neural Network(RNN), and TensorFlow algorithms using Keras for the training of the model, which can be accurately used for the classification of the digits.

Figure 1: Numerical Dataset from the MNIST Database

MNIST Database is standard for the handwritten numerical digits for this project, which is used for the classification in Handwritten Digit Recognition Using Supervised Learning. After converting the digits into pixels; therefore, the range extends from 0 to 255, for example, 0 for Black and 255 implies for White.

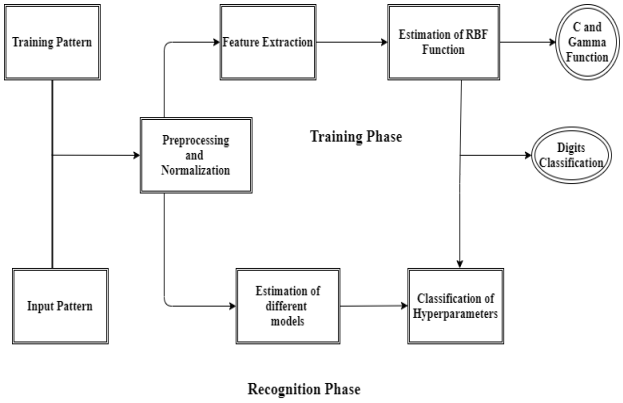


Figure 2: Architecture Diagram

Figure 2 illustrates the architecture diagram of the proposed system of the project. The proposed system has different stages, which will be used to classify the numerical digits. As the basic step of the project, the set of MNIST images will be used; therefore, figure 1 will be used as the dataset from the database.

IV. MATH

Whatever the process involved proving the proposed word scientifically is essential. Then only we can taste the actual sweet of the work. Initially, the work started with finding the distance from camcorder to thing/marker using Python .

This project "A Novel Interpolation Approach for Handwritten Digit Recognition Using Neural Network" has used some algorithms for the project to make it work perfectly which consists of the linear discriminant function, support vector machine, radial basis function(RBF), k-nearest neighbor classifier and works of all of this algorithm makes this project work properly.

Suppose a Multivariate Gaussian diffusion with same divergence diagram for each section, with a joined rate of the diffusion, the rectilinear discriminant obligation has the following form:

$$gi(x) = -12\ (x - \mu i)\ t\Sigma - 1\ (x - \mu + i) + \log P(\omega i)\ (1)$$

Using a lib-SVM for the trained and test data in the the Support Vector Machine (SVM) classifier. Based on previous reports and papers, choices of the kernel with associated parameters are specified :

• Radial Basis Function Kernel $k(xi , xj) = \exp(-\gamma kxi - yik\ 2), \gamma > 0$. By exclusion, lib-SVM selecting $\gamma = 1/d$, where d is the number of attribute and $d = 200$ which uses extricate direction characteristics. Such as, it is found where $\gamma = 0.005$ and the error value gets high which is 8.05% which is long lasting for data training. Therefore, change $\gamma = 0.5$ to specify smaller size window and the production which will turn and will be enhanced.

V. EXECUTIONAL SETUP:

Every project needs estimation to measure the accuracy as well as the performance of numerical digits. MNIST Database is standard for the handwritten numerical digits for this project, which is used for the classification in this project. To provide input to the system, the user can upload the image of the numerical digit he wants to detect or the data from the MNIST. The input is pre-processed. By different classifiers, the numerical digit's accuracy has been compared, and the result has been obtained and displayed along with the accuracy.

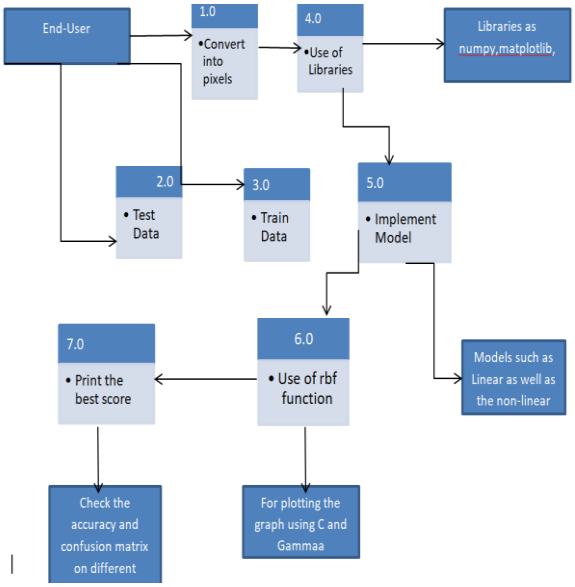


Figure 3:DataFlow Diagram of the System Model

Figure 3 illustrates the steps to be taken while performing execution; the CNN model works in this way. User first converts numerical digits into pixel format than with the use of the libraries the model is implemented, after this, the project uses radial basis function such as the two parameters C and Gamma used for plotting the graph and printing the best score based on the hyper-parameters and using other different algorithms to check the accuracy and confusion matrix.

To complete this work, the proposed model used various software and hardware tools, such as Tensorflow, Python 3.7, and Anaconda 3.7.1.

VI. RESULT:

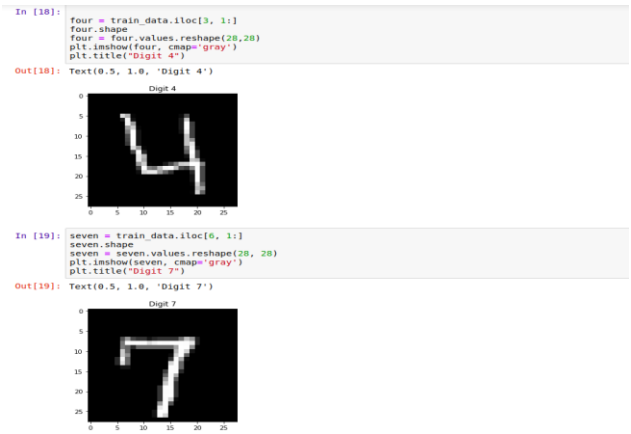


Figure 4:Output generated by the project

The above Figure 4 illustrates the output of the project, which is displayed as the numerical digits after the use and implementation of the models, which will provide appropriate output.

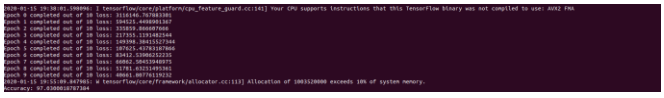


Figure 5: CNN illustration

Figure 6: DNN Illustration

Figure 7: RNN Illustration

The above Figures illustrate the classification algorithm such as CNN, RNN, DNN, which is used in the project to get the accuracy and confusion matrix in this project.

VII. CONCLUSION

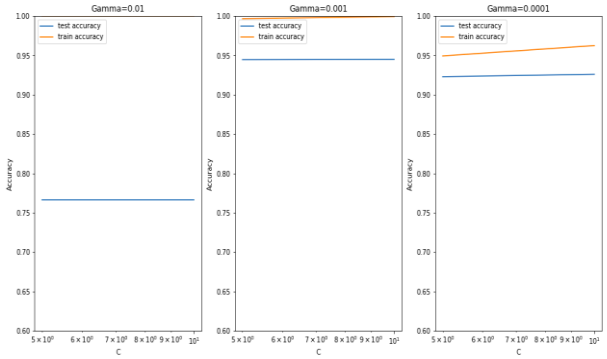
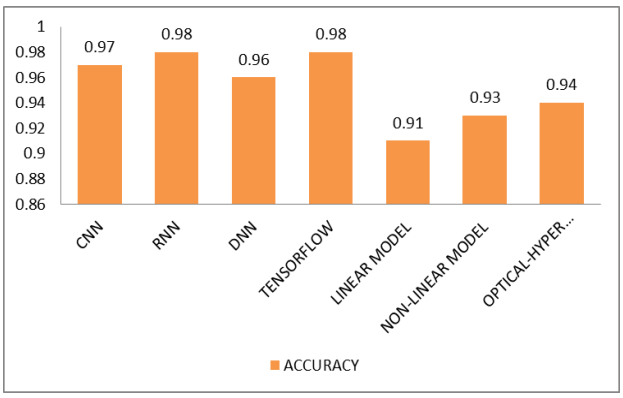


Figure 8: Graph plotted between C and Gamma Function

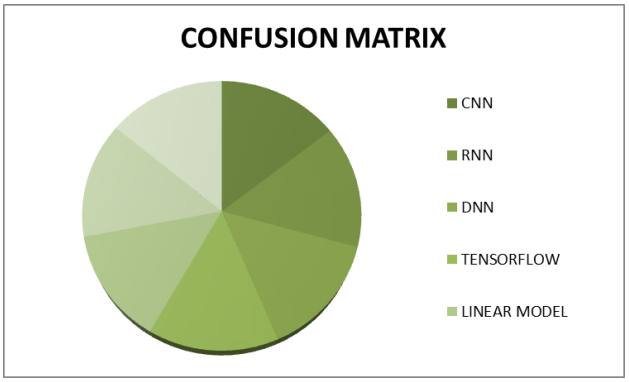
Table 1: Comparison between Models

ALGORITHM	ACCURACY	CONFUSION MATRIX
CNN	0.97	YES
RNN	0.98	YES
DNN	0.96	YES
TENSORFLOW	0.98	YES
LINEAR MODEL	0.91	YES
NON-LINEAR MODEL	0.93	YES
OPTICAL-HYPER PARAMETERS	0.94	NO

The above table describes the accuracy and confusion matrix of different algorithms; based on it, and the below graph has been plotted.



Graph 1: Graph plotted for Accuracy



Graph 2: Graph plotted for the confusion matrix

FUTURE WORK

The objective of this paper, Handwritten Digit Recognition Using Supervised Learning, has implemented. In this paper, different algorithms as CNN, RNN, DNN, and many other models such as Tensorflow, Linear Model, and Non-Linear Model have been trained as well as tested, which will acquire the comparison of all the models and algorithms. By the use of this, we will obtain accuracy, which will obtain the highest accuracy as 0.98% has been achieved in this paper as well as the confusion matrix has been obtained. The models have also been trained and getting the highest accuracy and epoch for different models used in this paper.

The proposed work has done implementation using the MNIST dataset through which the dataset will be downloaded and will be used during the project implementation of the numerical digits for the future scope of this project. We can use other symbols such as English alphabets or alphabets in other languages too.

REFERENCES

1. Elie Krevat, Elliot Cuzzillo. Improving Offline Handwritten Character Recognition with Hidden Markov Models.
2. Lisa Yan. Recognizing Handwritten Characters. CS231N Final Research Paper.
3. Oivind Due Trier, Anil K. Jain, Torfinn Taxt. Feature Extraction Methods for Character Recognition–A Survey Pattern Recognition. 1996
4. 4.TesseractModel:https://github.com/tesseractocr/tesseract/wiki/TrainingTesseract-4.00
5. Fabian Tschopp. Efficient Convolutional Neural Networks for Pixelwise Classification on Heterogeneous Hardware Systems
6. T. Wang, D. Wu, A. Coates, A. Ng." End-to-End Text Recognition with Convolutional Neural Networks" ICPR 2012.
7. Thodore Bluche, Jrme Louradour, Ronaldo Messina. Scan, Attend and Read: End-to-End Handwritten Paragraph Recognition with MDLSTM Attention.
8. Siva Shanmugam Gopal., & N.Ch.Sriman Narayana Iyengar,. (2019). Improving Energy Efficient and Impairing Environmental Impacts on Cloud Centers by Transforming VM into Self-Adaptive Resource Container. Int. Arab J. Inf. Technol., 16(4), 30-37.
9. Vijayalaxmi R Rudraswamimath, Bhavanishankar K, Handwritten Digit Recognition using CNN, International Journal of Innovative Science and Research Technology.
10. S. M. Shamim, Md Badrul Alam Miah, Angona Sarker,Handwritten Digit Recognition using Machine Learning Algorithms, Research Gate march 2018.
11. Layers Fathma Siddique1, Shadman Sakib , Md. Abu Bakr Siddique ,Recognition of Handwritten

Digit using Convolutional Neural Network in Python with Tensorflow and Comparison of Performance for Various Hidden
12. priya, rajendra singh, dr. soni changlani,Review on handwritten digit recognition, IJNRD Volume 2, Issue 4 April 2017.
13. Anushri Ravikumar, Ashitha Nayak ,Mamatha,Digit Recognizer, IARJSET Vol. 4, Special Issue 8, May 2017.
14. Meer Zohra, D.Rajeswara Rao,A Comprehensive Data Analysis on Handwritten Digit Recognition using Machine Learning Approach, International Journal of Innovative Technology and Exploring Engineering (IJITEE) Volume-8 Issue-6, April 2019
15. Joseph JamesS , C.Lakshmi, UdayKiran P, Parthiban,An Efficient Offline Hand Written Character Recognition using CNN and Xgboost, International Journal of Innovative Technology and Exploring Engineering (IJITEE), Volume-8 Issue-6, April 2019

AUTHORS PROFILE

Shruti Pandey, is currently doing M. Tech in Computer Science and Engineering from Vellore Institute of Technology, Vellore, also completed my B.tech in Computer Science and Engineering from JNTUK .I have developed an interest in machine learning which made me work in this project and created a keen interest to learn about Machine Learning.

Siva Shanmugam G, working as an Asst. Prof.& Research Scholar at SCOPE, VIT University, Vellore, TN, India. He has had 6 years of teaching experience and currently doing his Ph.D. research on Green Cloud computing. His interest includes Machine learning, Distributed Systems, Web Security, Sensor Networks, Mobile, and Internet Computing.