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Handwritten Digit Recognition Using CNN

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Abstract - *Deep learning has recently taken a radical turn in the field of machine learning by making it more artificially intelligent, thanks to the advent of Convolutional Neural Networks (CNN). Because of its wide range of applications, deep learning is used in a wide range of industries, including surveillance, health, medicine, sports, robots, and drones. Handwritten Digit Recognition is an example of a computer's capacity to recognise human handwritten digits. Because handwritten numerals aren't flawless and might be generated with a variety of tastes, it's difficult work for the machine. The purpose of this project is to provide a response to a current problem that uses a digit image and recognises the digit contained in the image using the Convolutional Neural Networks idea. The Modified National Institute of Standards and Technology (MNIST) dataset is used to train our model in this research. This dataset was created using the convolutional neural network technique and Keras, a Python library for intensive computation of neural nodes that is supported by the Tensor Flow framework on the backend. We will be able to estimate the handwritten digits in an image using this model. This approach allows us to detect numerous digits.*

Key Words: **Digit Recognition, MNIST, CNN**

1. INTRODUCTION

Handwritten digit recognition is currently used in a variety of user authentication applications. Because the handwritten numerals differ in size, thickness, style, and orientation. As a result, these obstacles must be overcome in order to solve the problem in my project. We will be utilizing a unique form of deep neural network called a Convolutional Neural Network, which is used to analyze visual imagery by converting massive amounts of pixel data into meaningful data that can be sent as input layer data to an convolutional Neural Network for training. After that, the system will create a model for handwritten digit recognition using hidden layers of CNN. On the Modified National Institute of Standards and Technology (MNIST) dataset, which contains 70,000 photographs of handwritten digits, we will apply a 7-layer LeNet-5 Convolution Neural Network technique. Keras, a Python-based neural network library, is used. The network is trained using the stochastic gradient and back propagation algorithms, and then tested using the forward method. Once the model is ready, the user can upload a picture containing digits and receive a proper forecast of their input.

1.1 Need of the project

Everything will be online in the future as we go into the digital era, and handwritten digit recognition will be the future. To create a handwritten digit recognition system that uses a deep learning model to allow users to automate the process of digit recognition. It is faster than traditional typing and hence saves time.

1.2 Existing Systems

Handwritten digit recognition is used in a variety of sectors, including the post mail sorting system, which queues scanned images of mail envelopes and extracts the part defining the postcode to be delivered. Sorting mails based on these postcodes according to their region can be done with the help of a digit recognizer. Form processing is another application that uses this technology. Digits are extracted from certain columns of a form, and users apply filters to acquire the desired results. However, there is no user interface for having their photographs scanned and recognised, making the operation difficult to use for the average user.

1.3 Scope

Handwritten digit recognition with a classifier offers a wide range of applications and uses, including online handwriting recognition on computer tablets, recognising zip codes on mail for postal mail sorting, processing bank check amounts, numeric entries in handwritten forms, and so on. When attempting to address this problem, there are a variety of obstacles to overcome. The size, thickness, orientation, and position of the handwritten numbers in relation to the margins are not always consistent. Our goal is to create a pattern classification algorithm that can recognise the user's handwritten numbers. The resemblance between digits such as 1 and 7, 5 and 6, 3 and 8, 8 and 8, and so on was the general challenge we thought we would meet in this digit categorization problem. Furthermore, people write the same digits in a variety of ways. Finally, the individuality and variation of each person's handwriting has an impact on the construction and look of the digits.

2. Literature Survey

Rohan Sethi & Ila Kaushik, et al., June 2020 [1] - describe optical digit identification in general and the stages required, such as picture acquisition, pre-processing, segmentation, feature extraction, classification, and post-processing. We referenced a number of other articles, including [2], [3], and [4], which assisted us in obtaining fresh information. The article then goes on to explain several classification methods such as the Naive Bayes Classifier, Nearest Neighbor, Logistic Regression, Decision Trees,

Random Forest, and Neural Network. They used the KNN Classification Algorithm in the paper, where they discuss the KNN architecture, steps involved in the algorithm, using the Euclidean distance formula to compute the nearest and most accurate labelled data so as to correctly classify the digits from the dataset, providing input from the MNIST database with moderately high accuracy output and less computation, and providing input from the MNIST database with moderately high accuracy output and less computation. 2) Anchit Shrivastava, Isha Jaggi, et al., Oct 2019 [2] discusses multilayer neural networks, which include preprocessing, feature extraction, and classification. They use the MNIST database to go over the many types of features used in feature extraction, such as structural characteristics, modified edge maps, image projections, and so on.

Multi-zoning, concavity measurement, and gradient features are all available. We also grasped the concept of multilayering from [8] [6]. They also discuss the error rate associated with various sorts of characteristics. They go on to explain convolution neural networks and how SVM is utilised as a classifier. To boost recognition accuracy, the training photos are retrieved from Alex-Net and multiple augmentation approaches are applied. 3) Aug 2020 [3] – Jinze Li, Gongbo Sun, Leiye, Qian Cao, et al. This research primarily offers a handwritten digit recognition system based on convolutional neural networks and deep learning[7]. The system uses the MNIST dataset as a training sample and uses the Opencv tools to pre-process the image. The Open CV Toolkit is a free and open source software library. OpenCV is utilised to perform image 13 pre-processing and feature extraction in this work. Then it utilises LeNet-5, a convolutional neural network with five layers, to extract the handwritten digit image features, convolution pooling repeatedly, and pulling the result into a one-dimensional vector.Finally, using the Softmax regression model, which is a generalised logistic regression model, identify the highest probability point to determine the result in order to perform handwritten digit recognition. 4) Yawei Hou & Huailin Zhao, Feb 2014[6] - shows that employing a simple model results in higher recognition. They investigate the back progression neural network and the convolution neural network (CNN) individually before presenting a strategy that combines the two and uses a deep neural network to improve recognition accuracy marginally. It begins with a brief explanation, followed by CNN.

3. Literature Survey

3.1 Design Software

Python was chosen because it is a readable language. Because the Python code is straightforward to grasp, it was simple to create machine learning models. Python also contains a vast number of libraries and frameworks. The libraries keras, Tensor Flow, and NumPy were utilised. Python is a high-level general-purpose programming language that is interpreted. The use of considerable indentation in its design philosophy emphasises code readability. Its language elements and object-oriented approach are aimed at assisting programmers in writing clear, logical code for both small and large-scale projects. Keras is the most widely used machine learning library; it is an open source software with a Python interface. It serves as a Tensor Flow interface.It's also simple to use. TensorFlow - For handwritten digit categorization, TensorFlow can train and execute deep neural networks. With the same models used for training, TensorFlow can predict production at scale. NumPy libraries — it's a fantastic tool for learning about machine learning, as well as mathematics and scientific calculations. NumPy is in charge of all mathematical tasks.

3.2 Dataset - MNIST

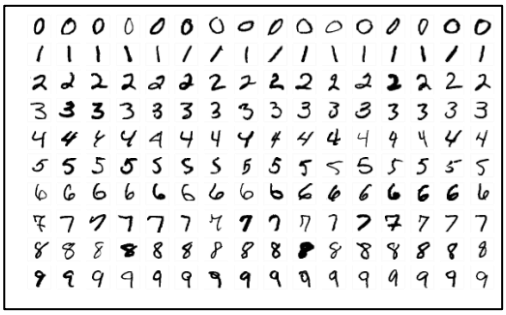


Photo credit – Wikipedia

The MNIST database (Modified National Institute of Standards and Technology database) may contain a significant number of handwritten documents. There are 60,000 training photos and 10,000 testing images in the database. It's a popular dataset that's also fully free. The error rate is also lower when compared to other data sets used in machine learning. The MNIST dataset's images have all been transformed to 28*28 pixels. Because it has a far higher accuracy rate than other datasets, the MNIST dataset is widely used across multiple machine learning languages. Using a committee of neural networks, some researchers have obtained "near-human performance" on the MNIST database; in the same study, the authors achieve performance double that of humans on other recognition tests. The database's maximum error rate, according to the original website, is 12%, which was attained using a simple linear classifier with no preprocessing. Researchers using a new classifier called the LIRA, which may be a neural classifier with three neuron layers based on Rosenblatt's perceptron principles, obtained a best-case error rate of 0.42 percent on the database in 2004.Some researchers put artificial intelligence systems to the test by putting a database through random distortions. These systems can be highly successful at times.

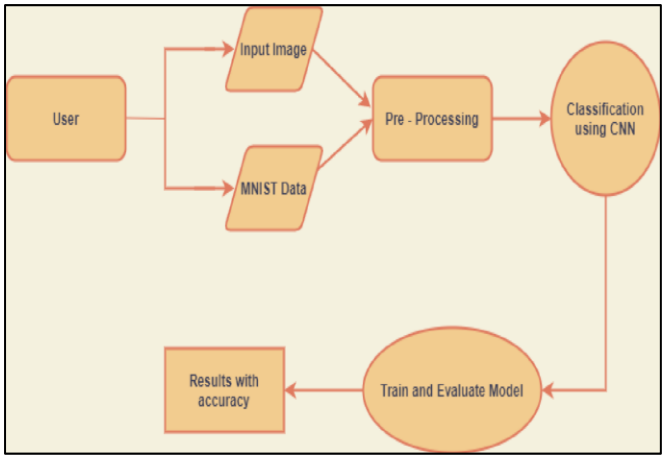
3.3 Methodology

Because of its great accuracy, Convolutional Neural Networks (CNNs) are utilized in image and digit recognition.

The fundamental advantage of CNN over its predecessors is that it automatically discovers significant features without the need for human intervention. As a result, CNN would be an excellent choice for digit and image classification tasks.

A neural network is a hardware and/or software system modelled after the way neurons in the human brain work. Traditional neural networks aren't designed for image processing and must be fed images in smaller chunks.

CNN's "neurons" are structured more like those in the frontal lobe, the area in humans and other animals responsible for processing visual inputs. Traditional neural networks' piecemeal image processing difficulty is avoided by arranging the layers of neurons in such a way that they span the whole visual field. The proposed system model's data flow diagram. There are two ways to give the system information. The user can either provide an image of the digit he wishes to detect or MNIST dataset data. Preprocessing is done on the input photos. The accuracy of recognised digits is compared using different classifiers, and a result is obtained. The correctness of the results is given alongside them. The first step is to place the dataset, which can be done quickly and easily using the Keras programming interface. The pictures in the MNIST dataset are in the form of a cluster, which consists of 28x28 values that make up an image and their label**s.**If there is a chance that the testing photos will appear, this is equal. The pixels are represented by a set of 784-d pixels with a range of 0 to 255, with 0 being black and 255 denoting white. Python is a high-level programming language that is widely used around the world. Its linguistic style allows software engineers to communicate concepts in fewer lines of code, and it was introduced particularly for prominence on code. Python is a programming language that allows you to work more quickly and efficiently using frameworks.



3.4 Architecture

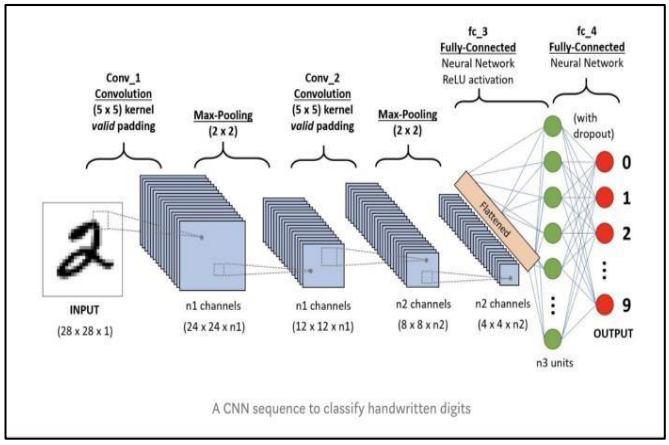
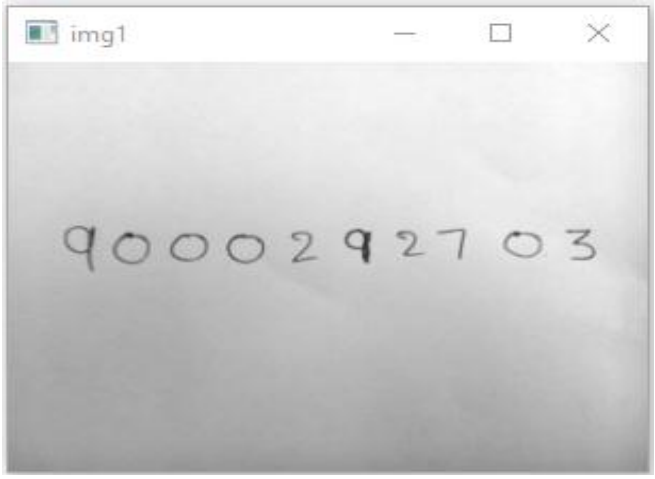


Photo credit - Nikita Sharma/ConfusedCoder.com/January 2019

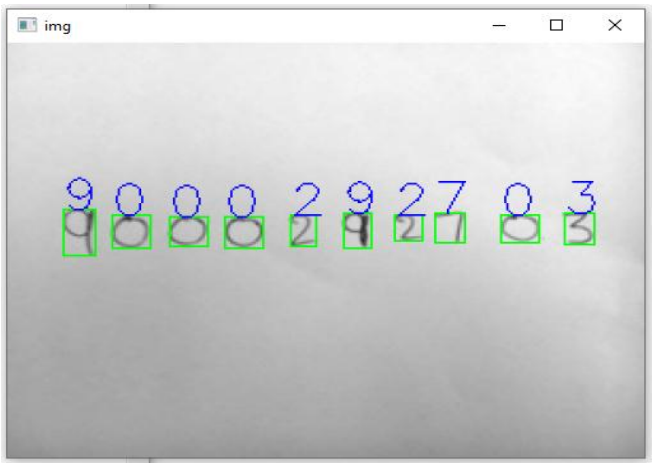
The image is compressed to 28 by 28 pixels in the first step. This compression is required in order to obtain quick results. Convolution 1 is the second step, which is kernel valid padding, which means there is no padding at all. The supplied image is preserved in its original state. The image is compressed to 24 by 24 pixels once again in this step. The image is further compressed to 12 by 12 pixels using max pooling. After that, the image is reduced down to 4 x 4 pixels using a convolution filter with maximum pooling. Finally, ReLu is activated before to CNN.Every pixel in the ReLu activation process is given a 0 or 1 value based on the preceding filters procedure. These values are then flattened before being transmitted to the MNIST training dataset. We acquire our result after comparing it to its data set.

3.5 Implementation



From (Fig 1) the digits are written on the paper and then uploaded to the output.

In (Fig 2) we can see that the digits are successfully recognized by the model. We can detect multiple digits. The accuracy of our model is about 90% based on 50 results.



4. CONCLUSION

On handwritten digit recognition, we have successfully constructed a Python deep learning project. We created and trained a Convolutional Neural Network (CNN) that is exceptionally good at picture classification. Handwritten Digit Recognition using Deep Learning Methods has been developed. In order to provide a comparison of the classifiers, the most frequently used Machine learning algorithms CNN were trained and tested on the same data. A great level of accuracy can be achieved with these deep learning approaches. Unlike other research methodologies, this one focuses on which classifier performs best by increasing the accuracy. A CNN model with Keras as the backend and TensorFlow as the software can achieve 90 percent accuracy.

REFERENCES

1) R. Sethi and I. Kaushik, "Hand Written Digit Recognition using Machine Learning," 2020 IEEE 9th International Conference on Communication Systems and Network Technologies (CSNT), 2020, pp. 49-54

2) A. Shrivastava, I. Jaggi, S. Gupta and D. Gupta, "Handwritten Digit Recognition Using Machine Learning: A Review," 2019 2nd International Conference on Power Energy, Environment and Intelligent Control (PEEIC), 2019, pp. 322-326

3) J. Li, G. Sun, L. Yi, Q. Cao, F. Liang and Y. Sun, "Handwritten Digit Recognition System Based on Convolutional Neural Network," 2020 IEEE International Conference on Advances in Electrical Engineering and Computer Applications(AEECA), 2020, pp. 739-742

4) Y. Hou and H. Zhao, "Handwritten digit recognition based on depth neural network," 2017 International Conference on Intelligent Informatics and Biomedical Sciences (ICIIBMS), 2017, pp. 35-38

5) K. T. Islam, G. Mujtaba, R. G. Raj and H. F. Nweke, "Handwritten digits recognition with artificial neural network," 2017 International Conference on Engineering Technology and Technopreneurship (ICE2T), 2017, pp. 1

6) M. Jain, G. Kaur, M. P. Quamar and H. Gupta, "Handwritten Digit Recognition Using CNN," 2021 International Conference on Innovative Practices in Technology and Management (ICIPTM), 2021, pp. 211-215, doi: 10.1109/ICIPTM52218.2021.9388351.

7) F. Siddique, S. Sakib and M. A. B. Siddique, "Recognition of Handwritten Digit using Convolutional Neural Network in Python with Tensorflow and Comparison of Performance for Various Hidden Layers," 2019 5th International Conference on Advances in Electrical Engineering (ICAEE), 2019, pp. 541-546, doi: 10.1109/ICAEE48663.2019.8975496.

8) P. Ma, "Recognition of Handwritten Digit Using Convolutional Neural Network," 2020 International Conference on Computing and Data Science (CDS), 2020, pp. 183-190, doi: 10.1109/CDS49703.2020.00044.

9) C. Zhang, Z. Zhou and L. Lin, "Handwritten Digit Recognition Based on Convolutional Neural Network," 2020 Chinese Automation Congress (CAC), 2020, pp. 7384-7388, doi: 10.1109/CAC51589.2020.9326781.

10) K. T. Islam, G. Mujtaba, R. G. Raj and H. F. Nweke, "Handwritten digits recognition with artificial neural network," 2017 International Conference on Engineering Technology and Technopreneurship (ICE2T), 2017, pp. 1-4, doi: 10.1109/ICE2T.2017.8215993.

11) D. Beohar and A. Rasool, "Handwritten Digit Recognition of MNIST dataset using Deep Learning state-of-the-art Artificial Neural Network (ANN) and Convolutional Neural Network (CNN)," 2021 International Conference on Emerging Smart Computing and Informatics (ESCI), 2021, pp. 542-548, doi: 10.1109/ESCI50559.2021.9396870.

12) R. Sethi and I. Kaushik, "Hand Written Digit Recognition using Machine Learning," 2020 IEEE 9th International Conference on Communication Systems and Network Technologies (CSNT), 2020, pp. 49-54, doi: 10.1109/CSNT48778.2020.9115746.