

Abstract and Scope

Abstract:

Purpose of the project is to identify a digit written by the user and correctly classify it between 0-9 numbers. The project also allows for live detection wherein user can draw a number in the window and the program classifies and displays the appropriate result in the same window.

Scope:

- MNIST Dataset is used to train the model using CNN and evaluation is done to identify accuracy and loss in the dataset.
- OpenCV is used to allow the user to draw a number and extract and identify the same using the model generated and finally display the same in the window.

Literature Survey

- **Paper Link:** [Click here](#)
- **Paper Title:** Validation of Random Dataset using an efficient CNN model trained on MNIST handwritten Dataset
- **Author's:** Adhesh Garg, Diwanshi Gupta, Sanjay Saxena , Parimi Praveen Sahadev
- **Date Of Publication/Published In:** 2019 6th International Conference on Signal Processing and Integrated Networks (SPIN)

- **Views on the Paper:**

The objective of this paper is to train a model that could classify a digit based on its pattern using CNN to recognize a similar pattern of the handwritten digit. Images are of English handwritten digits taken from a variety of resources, normalized to 28x28 size to fit into the model. The model is using four convolutional layers, in which after every two convolutional layers there are two max-pooling layers to extract features from the image. The model has an accuracy of 98.45% when tested with 300 training epochs and 200 validation epochs. To increase the efficiency of this CNN model, the testing could be done with a diverse dataset.

Literature Survey

- **Paper Link:** [Click here](#)
- **Paper Title:** Analyzing Decision Trees to Understand MNIST Misclassification
- **Author's:** Alexis Comeau, Christopher McDonald
- **Date Of Publication/Published In:** 2019 IEEE MIT Undergraduate Research Technology Conference (URTC)
- **Views on the Paper:**

The objective of this paper is to use a decision tree classifier to analyze the misclassification for the digits three and five, analyzing the nodes of the decision tree plot to understand the process of classification. Construction of the confusion matrix reveals that there are 40 threes predicted as fives and that there are 39 fives predicted as threes. The results show that a single pixel difference (namely pixel325 and pixel95) in both the numbers can cause wrong classification of the numbers. Possible directions for easier identification of the pixel would be to automate the identification and manipulation of misclassified digits, rather than manually identifying the sequence of nodes and changing the pixel values accordingly.

Literature Survey

- **Paper Link:** [Click here](#)
- **Paper Title:** Effective Algorithms and Methods for Automatic Number Plate Recognition
- **Author's:** Amirgaliyev Beibut, Kairanbay Magzhan, Kenshimov Chingiz
- **Date Of Publication/Published In:** 2014 IEEE 8th International Conference on Application of Information and Communication Technologies (AICT)

- **Views on the Paper:**

The objective of this paper is to construct an algorithm which will identify the location of number plate in the frame, extract the characters from it, and then recognize them. The proposed approach firstly transforms the image to grayscale, blurs the image to reduce noise and uses a modified version of Sobel algorithm for detecting vertical edges and close morphology is used to combine close elements together. To extract the digits from the number plate the image is projected onto the X axis and identification is done through a 1NN algorithm which divides the image into 49 subparts and counts the number of white pixels. The accuracy of the proposed model is 90% and improvements include optimizing the segmentation algorithm and gathering more data for training.

Literature Survey

- **Paper Link:** [click here](#)
- **Paper Title:** A KERAS BASED IMPLEMENTATION FOR EFFICIENT HANDWRITTEN DIGIT RECOGNITION USING CONVOLUTIONAL NEURAL NETWORKS
- **Author's:** Muzamil Nawaz, Sandesh Gangwani and Isma Farah Siddiqui
- **Date Of Publication/Published In:** 2020, Department of Software Engineering, Mehran University of Engineering and Technology, Jamshoro, Pakistan.
- **Views on the Paper:**
 - The objective of the paper is to define a process of handwritten digit recognition using Python and Keras(a deep learning library used in python).Output is described in prediction error which is calculated by inverting accuracy of model. Less prediction errors indicates better trained model. Better results are achieved by using extra convolutional layers before passing data to the hidden layers.

Literature Survey

- **Paper Link:** [click here](#)
- **Paper Title:** Handwritten Digits Recognition Using PCA of Histogram of Oriented Gradient
- **Author's:** Wu-Sheng Lu
- **Date Of Publication/Published In:** Electrical and Computer Engineering University of Victoria, Victoria, BC, Canada.
- **Views on the Paper:**

This paper presents a multiclass classifier based on principal component analysis (PCA) of histogram of oriented gradient (HOG) for accurate and fast recognition of handwritten digits. HOG is known as an effective feature descriptor for computer vision and image processing, and PCA has shown its ability for fast multiclass recognition. By combining PCA with HOG, the PCA-of-HOG based classifier is developed. The proposed algorithm was applied to the MNIST database of handwritten digits to demonstrate its performance in comparison with classifiers based on PCA of raw input data.

Literature Survey

- **Paper Link:** [click here](#)
- **Paper Title:** Survey on Handwritten Digit Recognition using Machine Learning
- **Author's:** Narender Kumar , Himanshu Beniwal.
- **Date Of Publication/Published In:** June 2018, Department of Computer Science and Engineering, H.N.B. Garhwal University, Srinagar Garhwal, Uttarakhand, India
- **Views on the Paper:**
The main thing that we Focus in this paper is how good the performance is with conventional neural network (CNN). By comparing the classifiers of all other models like KNN, PSVM, ANN, SVM, MCDNN, and convolution neural network on basis of performance, accuracy, time, sensitivity, positive productivity, and specificity with using different parameters with the classifiers.

Literature Survey

- **Paper Link:** [Click here](#)
- **Paper Title:** Design and implementation of handwritten digit recognition system based on template method
- **Author's:** Yang Zhiqi; Fu Kai
- **Date Of Publication/Published In:** 2018 IEEE 3rd Advanced Information Technology, Electronic and Automation Control Conference (IAEAC)
- **Views on the Paper:**

This paper implements a digit recognition system based on template method. Feature extraction involves dividing the the length and width of each sample image by M to form a uniform small area of M*M cells and finding the proportion of black pixels in each cell. The proportion of black pixels in these cells determine the eigenvalues of the template. In this paper, the shortest distance between images is used as a discriminant function which is calculated by using Mahalanobis distance.

Literature Survey

- **Paper Link:** [Click here](#)
- **Paper Title:** Handwritten Digits Recognition with Artificial Neural Network
- **Author's:** Kh Tohidul Islam , Ghulam Mujtaba , Dr. Ram Gopal Raj , Henry Friday Nweke
- **Date Of Publication/Published In:** 2017 International Conference on Engineering Technology and Technopreneurship (ICE2T)
- **Views on the Paper:**

This implementation of artificial neural network for recognizing handwritten digits from 0 to 9 takes 28X28 pixel images(from the MNIST dataset) as input. Raw pixels were used as features, therefore a 28X28 pixel image has 784 features. This model of ANN had one hidden layer of 100 neurons alongside 784 input neurons(1 for each pixel) and 10 output neurons(1 for each digit). The model was trained with 25200 samples. 1400 samples were used for validation and 1400 for testing. The network achieved an accuracy of 99.6% on the test sample after 107 epochs.

Literature Survey

- **Paper Link:** [Click here](#)
- **Paper Title:** Handwritten digit recognition based on DCT features and SVM classifier
Author's: Bouchra El qacimy; Mounir Ait kerroum; Ahmed Hammouch
- **Date Of Publication/Published In:** 2014 Second World Conference on Complex Systems (WCCS)
- **Views on the Paper:**

This system uses DCT(Discrete Cosine Transform) to reduce dimension/features of the sample data. DCT extracts the optimal features that reduce the dimension of MNIST data in order to speed up the learning algorithms while maximizing the classification accuracy.

This paper has compared the performance of the following four variants of DCT:

- 1 DCT Upper Left Corner(ULC) coefficients. (15X15 features)
- 1 DCT zigzag coefficients. (10X10 features)
- 1 Block based DCT ULC coefficients. (4X4 features in each block of 7X7 pixels)
- 1 Block based DCT zigzag coefficients. (10 coefficients in each block of 7X7 pixels)

Design Approach

What is the design approach followed? And Why?

The CNN model is designed to have an input shape of 28X28 and an output layer of 10 neurons with softmax activation.

Benefits of this approach & are there any drawbacks?

CNN is very accurate at image classification and recognition.

CNN requires a very large dataset to achieve good accuracy.

Alternate design approaches, if any.

Design Constraints, Assumptions & Dependencies

Discuss the design constraints and assumptions that you have made to select the design approach.

The main constraint was accuracy in recognition of the numbers, The assumption that we made was CNN classifier works with more accurate than any other classifier.

Discuss any dependencies that your design approach has and their impact on the project.

Architecture

Provide high-level design view of the system.

- Division into training and testing sample.
- Preprocess data.
- Train and test model with appropriate inputs.
- Live Prediction.

Technologies Used

What technologies you plan to use and why

Keras - deep learning library(we used keras to build and train the CNN model)

- opencv-python - to implement the live predictorCNN model for classification.
- OpenCV for live prediction.
- matplotlib for plotting accuracy and loss graphs.

References

- A. Garg, D. Gupta, S. Saxena and P. P. Sahadev, "Validation of Random Dataset Using an Efficient CNN Model Trained on MNIST Handwritten Dataset," 2019 6th International Conference on Signal Processing and Integrated Networks (SPIN), 2019, pp. 602-606, doi: 10.1109/SPIN.2019.8711703.
- A. Comeau and C. McDonald, "Analyzing Decision Trees to Understand MNIST Misclassification," 2019 IEEE MIT Undergraduate Research Technology Conference (URTC), 2019, pp. 1-4, doi: 10.1109/URTC49097.2019.9660504.
- A. Beibut, K. Magzhan and K. Chingiz, "Effective algorithms and methods for automatic number plate recognition," 2014 IEEE 8th International Conference on Application of Information and Communication Technologies (AICT), 2014, pp. 1-4, doi: 10.1109/ICAICT.2014.7035951.
- Muzamil Nawaz, Sandesh Gangwani and Isma Farah Siddiqui* Department of Software Engineering, Mehran University of Engineering and Technology, Jamshoro, Pakistan
- Wu-Sheng Lu , Electical and Computer Engineering University of Victoria, Victoria, BC, Canada.
- Narender Kumar , Himanshu Beniwal, June 2018, Department of Computer Science and Engineering, H.N.B. Garhwal University, Srinagar Garhwal, Uttarakhand, India
 - Design and implementation of handwritten digit recognition system based on template method Yang Zhiqi; Fu Kai 2018 IEEE 3rd Advanced Information Technology, Electronic and Automation Control Conference (IAEAC)
 - Handwritten digits recognition with Artificial Neural Network Kh Tohidul Islam; Ghulam Mujtaba; Ram Gopal Raj; Henry Friday Nweke
 - Handwritten digit recognition based on DCT features and SVM classifierBouchra El qacimy; Mounir Ait kerroum; Ahmed Hammouch 2014 Second World Conference on Complex Systems WCCS

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